special recorder issue
PART 1

PREVIEW OF 4TH INTERNATIONAL AUTOMATION EXPOSITION—EXHIBITORS & PRODUCTS

OUR 31 ST YEAR

INCLUDING: INSTRUMENT MANUFACTURING • JOURNAL OF THE SCMA • SIMULATION COUNCIL NEWSLETTER

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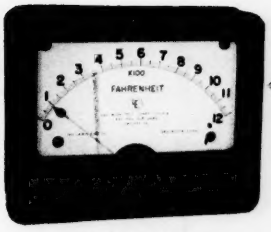
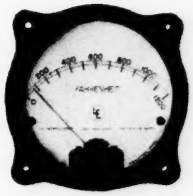


MODEL 58PY

Manufactured with the same type of movement as our aircraft pyrometers, the Model 23B pyrometer is well suited for use in moving vehicles and has been successfully used in many marine diesel installations for measuring exhaust temperatures. It is housed in a 4 in. round bakelite case that is flanged for panel mounting, and is available in several ranges for use with various thermocouple materials.



MODEL 23B

The Model 20B series of indicators are patterned after our standard aircraft instruments and are supplied with 3" round steel cases suitable for panel installation. These compact, sturdy indicators have 2⅛ in. scales, are fully cold-end compensated and are available in many ranges for use with various thermocouple materials.

MODEL 20B

The Model 62RT4F resistance thermometer is a sturdy easy-to-read instrument with a 6 in. hand drawn scale. It is suitable for use in moving vehicles and is excellent for flight-test work. It is operated by an ordinary dry cell and is calibrated to standard "AN" bulb curves for various ranges in fahrenheit or centigrade.

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Specialists in Electrical Temperature Measurements

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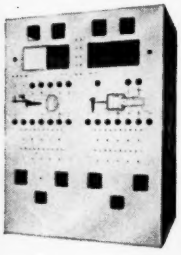

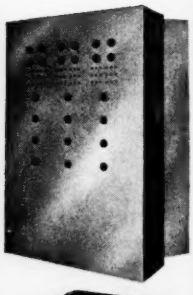

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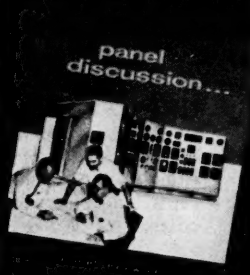

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MAY 1958

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For the Measurement of SOLAR RADIATION

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to the editor

Editor, I&A:

There is a lot of truth in your January "Systems" issue which will be passed over by the men who ought to read it simply because it is the sort of thing engineers do not read. On the other hand, if a handful of the right men read and heed, the effort is well spent.

Systems engineering, in an unnamed form, has been with us for a long time. It is not so much systems as it is the oversold and slightly sensational connotations that are at the root of the trouble. On every turn we hear about computers, digital control, the automatic plant; there seem to be not enough people (in the right places) who can sort the good from the bad, the applicable from the unapplicable—it's an experience factor and it's hard to come by.

Systems engineering as touted today has been oversold. Those who buy without experience will have it soon—perhaps to the extent that the pendulum will swing the other way. This would probably be as unfortunate as the current situation. There is a place for the systems engineering company because the small firm cannot maintain the department to study its problems once every five years. There are still some chemical companies that do not have an instrument engineer.

Until a system can be sold as a workable application without the overtones of sophistication, the industry is in trouble.

Your Systems Engineering Council has merit only if the basic provisions are rigidly enforced and there is sufficient good name that the customer will use it.

Byron White
Quarie Controllers
Canton, Mass.

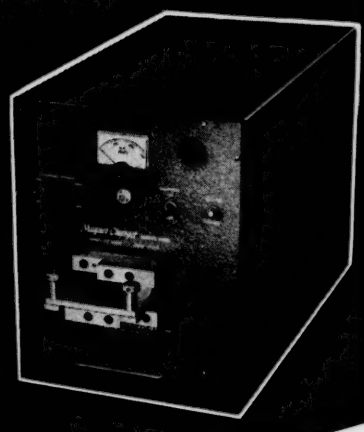
See page 829.

Editor, I&A:

The January issue of *Instruments and Automation* gives good treatment to a good concept. However, we do not believe the concept is as new as you infer . . . Certainly it takes a strong stimulus and continued drive to implant such a concept and perhaps in this light you are justified in over-stressing the "newness" as one stimulus.

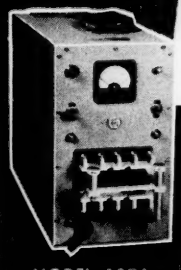
Your editorial shows serious thought to organize and correlate a

Magnet Charger



MODEL 1500
with Dual Ranges to 40,000 Ampere-Turns

3 VERSATILE MODELS



MODEL 107A

Designed for production, research and instrument repair work, the Model 1500 will magnetize the new cobalt platinum and barium ferrite materials as well as all the Alnicos. It will saturate large switchboard meter assemblies and all panel type instruments and uses most existing adapters designed for the Model 107A. Wire-wound fixtures are plugged into front panel through a safety interlock system providing maximum operator protection. Operates from 115-volt, 60 cps line. Size 11 x 20 x 15; weight 125 lbs. Price $945.

A basic condenser discharge unit for most medium size magnets, the Model 107A provides ranges of 12,000 and 24,000 ampere-turns. It is capable of saturating most instrument magnets, including the new core type mechanisms, using adapters or wire-wound fixtures. Designed for continuous duty. Operates from 115-volt, 60-cycle line. Price $530.

MODEL 942

A high powered magnetizer (up to 200,000 ampere-turns) capable of charging large Alnico and ceramic magnets of various shapes or pole configurations. Adapters for multi-pole rotors, rod, bar, ring and other shapes are available. Designed for continuous production use. Size 30" x 33" x 38"; weight 235 lbs. with 200-uf unit. Price of basic unit is less than $2100.

Performance of all models is rigidly guaranteed. Prices are net f.o.b. Boonton, N.J. and subject to change without notice.

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LETTERS—CONTINUED

large subject with many ramifications. The whole issue, as a matter of fact, is one of your best.

Clark Fishel
Texas Instruments, Inc.
Dallas, Texas

Editor, I&A:

I read your editorial and agree that the time has come for the formulation of a Systems Engineering Council such as you suggested. There is considerable overlapping (and animosity) between the manufacturers and systems people, largely because the latter are all potential hardware competitors.

Dr. Martin L. Klein
Director, Res. Div.
Cohu Electronics, Inc.
Van Nuys, Calif.

Editor, I&A:

You may be interested in some of my observations while overseas.

Turkey imports all instruments, industrial as well as scientific. However, a factory is being started, just where I do not know, to make water meters and gas meters, which are generally used in the cities. Watt-hour meters in use come from Austria or Yugoslavia or Germany or Czechoslovokia. What a repair problem!

While in Tel Aviv, consulting with the Israel Standards Institution, I note that there is no extensive instrument industry in Israel, only users. But there is great deal of industrial activity, and a good deal to see and learn, all of interest. I note also that Instruments Publishing Co., Ltd., your subsidiary in England, is exhibiting at Olympia, London, in the Instruments, Electronics, Automation Exhibit, April 16-25.

I should add that hotels here in Israel are crowded, and will be most of the summer, because of the celebration of the 10th anniversary of the founding of Israel.

W. G. (Brom) Brombacher
U. S. Operating Mission
Tel Aviv, Israel

Editor, I&A:

The "Odd Rule" described by Girard Schivley in your March issue is not completely new. An associate of mine, Mr. Bob Hockenberger, owns a rule with 32nds along one edge (odd ones numbered) and

odd 64ths along the other edge (every other odd one numbered, the series being 3, 7, 11, 15, etc). Mr. Hockenberger says that he has had the rule for at least 5 years. He has found it confusing to use. The rule carries the following inscription: Simplified Rule Company, Philadelphia, Penna., Stainless Steel No. 2, Pat No. 1,816,548.

I enjoy every issue of INSTRUMENTS AND AUTOMATION.

J. H. Schmidt
Engine Controls Engineering
AC Spark Plug Div.
General Motors Corp.
Milwaukee, Wisc.

Editor, I&A:

I was extremely gratified to read the editorial in *Instruments and Automation* on the results of the first two months operation of the Instruments and Automation course instituted in the Pittsburgh Public School System. Being a graduate of The Bronx High School of Science, I am well aware of how proper motivation and facilities can contribute to the development of our youth in the scientific and technical fields that are so urgently needed by our country.

I am not at all surprised at the success of your program for it has been shown time and time again that our youth, given the proper motivations and facilities, can turn to the task of developing the skill needed by the technology of today with unsurpassed vigor. Unfortunately, it is only by a great deal of work and argument, such as your committee has undertaken, that the majority of educators and other federal and civic organizations responsible for the education of our youth, can be made to realize the dire necessity of embarking on such programs.

I have talked with several of the leading educators in my area. They all agree that something should be done to encourage students to take the necessary types of courses that would prepare them to go into further work in the fields of science and technology. I regretfully have to say that not one of them had any concrete plans to implement the President's request for a greater emphasis on science education other than to offer an additional year of science or math to their students.

The idea of asking for help from local industrial and professional organizations where, after all, their "end products" will be used, has not occurred to them. These educators stated, as you pointed out, that most

RAMBLINGS ON INSTRUMENTATION

(Our advertising manager, a beleaguered soul, has asked that we doff the mantle of restrained intimacy with which we approach these "Ramblings" and, for crying out loud, put some punch in this particular column. Regular readers may be shocked but, it is hoped, will sympathize with the pressures that beset us. So they want an ad with some socko, hey. Here goes:)

New Hays Universal Recorder Acclaimed As "Not Bad!"

Those who saw it for the first time couldn't believe it! That's right . . . the group that first saw the new Hays recorder at a trade show preview simply couldn't believe that anyone could be silly enough to bring a new recorder into a world already glutted with recorders.

However, when they were told that the new Hays Universal Electronic Recorder has the new, streamlined "sheer look," their indifference changed to apathy!

Furthermore, when one hardboiled plant superintendent heard that the new Hays recorder has three basic interchangeable receiver units, he said "*Ummh.*"

That's not all! When this group actually saw with their own eyes how an almost unlimited variety of variables can be recorded—all in one basic recorder—they turned to one another and murmured, "What's for lunch?"

(At this point we discovered we were at the wrong show . . . the National Pickle Packers Convention, as a matter of fact. Some mix-up about dates.)

As it turned out, the pickle packers actually *were* intrigued by the recorder's new Hays Constant Voltage Unit for potentiometer applications . . . especially when they learned that this little Rock of Gibraltar has a stability of ±0.05% on a 20% supply voltage variation. And, no standard cells, batteries, sleight-of-hand or electronic tubes are involved!

In case you missed the National Pickle Packers Convention, here are the facts. The three interchangeable units are:

Slidewire Receivers—for potentiometer and resistance bridge applications.

Differential Transformer Receiver—for recording flow, level, pressure, temperature or input motion, using standard Hays transmitters. Sensitivity here is rather impressive, even to a pickle-packer . . . ±0.1% of *transmitter* differential transformer core motion.

As displayed at the National Pickle Packers Convention.

Mechanical Receivers—for direct recording of pressure and temperature using bellows, bourdons and gas-filled temperature system.

We also have a number of accessories for each electronic receiver. These range from adjustable switches and retransmitting slidewires to 300° indicators and retransmitting differential transformers. A maximum of two integrators or two pneumatic transmitters or controllers can be hung on the chart plate.

To show how this bric-a-brac can be combined, let's start with a flow receiver with slidewire, add a differential temperature (resistance bulb) receiver with slidewire, feed outputs of these two slidewires into another slidewire receiver, throw in an integrator, and *voila!* . . . a BTU Recorder with flow record and integration plus Delta T record and BTU record—all in one case. Interested? We'll send you details.

Hays' Give-Away Department

- Universal Recorder Bulletin, 57-1190-47
- Universal Recorder Specification Sheet, 58-1223-41
- Universal Recorder Bank Carton

Phil A. Sprague
President

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LETTERS—CONTINUED

of the top teachers in the fields of science have left the teaching field to enter industry, leaving public educators to carry on an increased educational program with limited facilities. I reiterated that this made it increasingly important for them to enlist aid from outside sources and I showed them the several articles on your program, pointing out what can be done with the proper co-operation of industry and education.

At the present time that is as far as it has gone. I hope to have the time to follow-up the developments in my area. I have a personal interest in this program, being in the field of Technological Education and having two sons whom I hope will get the kind of education they need for this complex society we live in.

I look forward to reading of further progress with your program. I would also be interested in observing your program in action, and wonder if it would be possible to arrange a visit to Pittsburgh in the near future.

Roy Golub
Test Instrumentation Engineer
Reaction Motors, Inc.
Denville, N. J.

Nothing could please us more!

Editor, I&A:

I would like to know why a Brown Instruments strip chart chassis was shown in an inverted position in the Royson "New Instrument" item which appeared in the October 1957 *I&A* (page 1918).

Norman L. Krusen
Minneapolis-Honeywell Regulator Co.
Phila., Pa.

We could say "examination of shadows on glossy indicated that position"—but it was probably just a mistake.

Editor, I&A:

As the editor of *Instruments & Automation* and as a well-known personality in the field of instrumentation, I would like to ask your advice.

After years of industrial instrument work, I intend to enroll in engineering. As no exclusive course exists for instrument engineering as such, I am undecided about the choice of engineering to take.

For practical instrument engineering, Chemical and Electrical Engineering are probably the two faculties under consideration. I am aware that the type of industry determines engineering requirements, such as the preference for a Chemical Engineer in refinery instrumentation. However, considering the mounting expansion in electronic computing and control systems, perhaps a degree in Electrical Engineering would be more advantageous for the latter applications.

I would appreciate your advice.

E. J. Kuhlmann
Instrument Chief,
Gunnar Mines Limited
Uranium City, Saskatchewan

Your letter poses a provocative problem. Today one finds electrical engineers, chemical engineers, physicists, mechanical engineers, etc., etc., at work as instrument engineers. The question is which course to take for a future in instrumentation?

You answer the question properly when you say chemical engineering if process instrumentation is the major desire.

The sole problem arises from the increasing role of electronics and computing, tending to a course in EE. This conclusion is not a totally solid one because (1) modern chemical engineering courses now give electronics and computing fundamentals; (2) the application of electronics and computers to processes requires more, not less, basic and fundamental knowledge of the process and its characteristics.

If process instrumentation is the goal, emphasize the process. The best bet thus still appears to be chemical engineering—with the understanding that instrumentation is so very "horizontal" that any type of engineer can select instrumentation as a career.

I can think of no better preparation for college than practical experience in instrumentation—and we predict a happy future for you. Good luck.

Editor, I&A:

[Regarding your school program]. Teaching unrelated in a practical application is wasted effort . . . the young folks deserve a better break.

Frederic E. Elliott, M.D.
Brooklyn, N. Y.

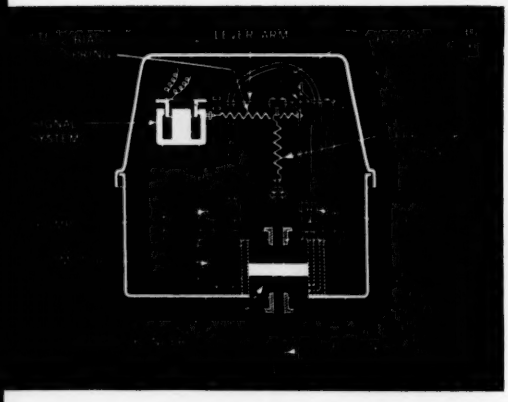
This experiment can be defined as "teaching related to practical application."

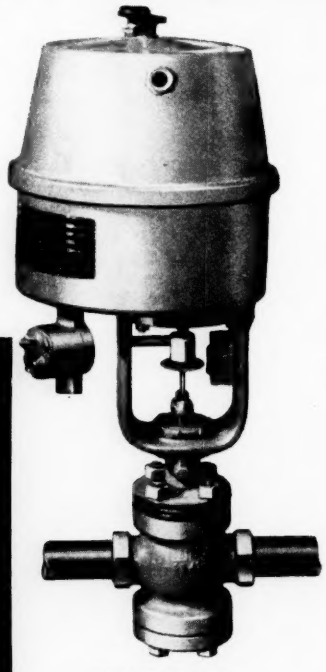
A faster, more accurate LOW-COST way to operate valves from an electrical signal

ASKANIA

EHVA

ELECTRO-HYDRAULIC VALVE ACTUATOR

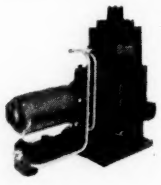




COMPLETELY SELF-CONTAINED

Above: Model RB-684 EHVA with a stall thrust of 1500 lbs., valve stem speed up to .9 i.p.s

Below: Crank-type EHVA has stall torque of 4,000 in.-lbs.



For any sliding-stem control valve with ½" to 1½" stroke and requiring less than 235 lbs. thrust, the Askania Model RF-697 Electro-Hydraulic Valve Actuator uses the famed Askania Jet Pipe Principle to give all the advantages of hydraulic valve operation from a low-level AC or DC signal. Standard range is 1 to 5 ma. DC.

The compact housing, only about 13" in diameter, contains the entire operating mechanism—signal system, Jet Pipe relay, pump, motor, work cylinder, valve position feedback, and oil reservoir—even the rectifier for AC signals. There are no gears or complicated linkages. It mounts directly on sliding stem control valves; with simple adapters it can be applied to a butterfly or cock-type valve, or to other types of mechanisms. Hydraulic operation is fast, positive, and precise. And Askania gives hydraulic operation straight-line simplicity, for easy installation, low maintenance, and long service life.

Only Askania, with a world of experience in adapting hydraulic power and precision to automatic control problems, could bring you this improved, compact unit at such an unbelievably low price! Mail the coupon today for all the facts about Model RF-697 and other Askania Electro-Hydraulic Valve Actuators.

ASKANIA — GENERAL PRECISION EQUIPMENT CORPORATION — GPE

Askania Regulator Company—A Subsidiary of General Precision Equipment Corporation

STRAIGHT-LINE AUTOMATIC CONTROLS FOR INDUSTRY

•

SYSTEMS ENGINEERING

•

VALVE ACTUATORS AND CYLINDERS

•

HYDRAULIC POWER AND PRECISION FOR AUTOMATIC CONTROL

Askania Regulator Company
268 E. Ontario Street, Chicago 11, Illinois

Please send me all the facts about Askania Electro-Hydraulic Valve Actuators.

Name ..... Title .....

Company .....

Street .....

City .....

For more information circle **10** on inquiry card.

LETTERS—CONTINUED

Editor, I&A:

I have followed your magazine for the past several years, and have been a particularly avid reader since Martin Klein started the articles on digital automation two years ago . . . I hope they aren't finished.

Robert Gentry, Jr., M.D.
LaMarque, Texas.

Martin Klein's series (21 chapters) are now being made available in book form under the title DIGITAL TECHNIQUES FOR COMPUTATION AND CONTROL, which is now available. We predict that this work will become one of the most important contributions of the year to the literature of the field. The Digital Automation series continues in I&A.

Editor, I&A:

Your new covers are a great improvement over the old covers; however, the old ones did serve their purpose very well.

In complimenting you on your new cover design, I would like to point out something that you are fully aware of—which is, that it's what's under the cover that counts. I know from having followed *Instruments & Automation* magazine for many years that you have kept the inside of the magazine fully abreast with the needs of your readers and are doing so right now.

G. P. Lonergan
The Bristol Company
Waterbury, Conn.

Editor, I&A:

I have noticed the new covers on *Instruments & Automation and you* are to be congratulated.

George Stauter
Minneapolis-Honeywell
Regulator Company
Brown Instruments Division
Philadelphia, Pa.

Editor, I&A:

Your new covers look "quality" and I think they do a good job for you.

S. D. Ross
Harris D. McKinney, Inc.
Philadelphia, Pa.

Editor, I&A:

[Regarding your high-school program]. The program laid out and put into effect by your group appears to

be realistic and designed to generate student interest in engineering or science training at the college-level.

L. C. Hill
Crucible Steel Co. of America
Pittsburgh, Pa.

Editor, I&A:

American Technical Society is currently working on a new edition of our *Electrical and Electronics Dictionary* . . . . have you published articles on instrument terminology?

William McHugh
Chicago, Ill.

Several efforts on terminology are now beginning in the field. Our definition of automation is the simple one: "use of devices—pneumatic, hydraulic, mechanical, electrical or electronic—to perform automatic decisions or efforts."

Editor, I&A:

Your high-school automation-instrumentation program is building up quite a reputation, not only in the state but in all the eastern United States, since we are continually getting inquiries about it.

William L. Cooper, Chief
Trade and Industrial Education
Commonwealth of Pennsylvania
Department of Public Instruction
Harrisburg, Pa.

Editor, I&A:

The October, 1957, issue of INSTRUMENTS AND AUTOMATION carries an article entitled "High-Temperature Measurements" . . . This article is the type I like, short but packed with a lot of information.

J. Boyce Rasco
Research & Development Dept.
Cabot Carbon Co.
Pampas, Texas

We try to make all I&A articles "short but packed with information."

Editor, I&A:

I am presently engaged in reading a copy of your *Electronic Circuitry for Instruments and Equipment.* First off, I would like to congratulate you on your intelligent approach to the problem of presenting electronics in an easily understandable form. Aside from basic electricity, which I studied in college, I have no training at all in electronics and am trying to learn it in spare time. This is the best book I've seen on the subject. I especially like the test questions at the end. They help in understanding the subject matter.

Second, I am writing to point out a couple of errors which, though not serious and not technical errors, are somewhat distracting to the reader. They will no doubt be corrected in subsequent printings of the book . . . Thank you again for your contribution to electronics literature.

James D. McCallum
Pasadena, Texas

Yes, the second edition (now available at $2) has fewer errors than the first! Thanks for the expression of appreciation.

Reader Inquiries

Vinyl Chloride Vapor in Air

Industrial Equipment firm in France is seeking portable apparatus to measure presence of vinyl chloride vapor in air or air-nitrogen mixture to 500 ppm to indicate doses dangerous to health. A-312

Force Gage

Engineer wishes contact with manufacturers of force gages of the type that may be used to measure the weight exerted on a phonograph record by the tone arm. A-313

Liquid Filling by Weight

Director of purchases desires information on manufacturers of filling machines measuring liquids by weight. A-314

Digital Time Counter

Consulting engineer wishes to contact manufacturers of high-frequency synchronous-motor counters (possibly 500 cps) for measuring gas flow in refinery. A-315

Automatic Weighing and Recording Systems

U. S. Post Office Department is interested in receiving offers from companies manufacturing automatic weighing and recording systems in the range from 2 to 100 pounds. A-316

Small Optical Galvanometer

Engineer is interested in information on small optical galvanometer. A-317

LIBRASCOPE
analog digital
converters
shaft to
digital encoders

Features of Librascope Shaft Position-to-Digital Converters include serial/parallel time sharing, double brush pick-offs, no dead time, variety of codes, digital-analog and analog-digital conversions. They are designed for the transfer of data from a shaft position to a form suitable for digital computers or data logging systems. Special converters are designed to meet customer requirements (including Sine Cosine). Please submit desired characteristics.

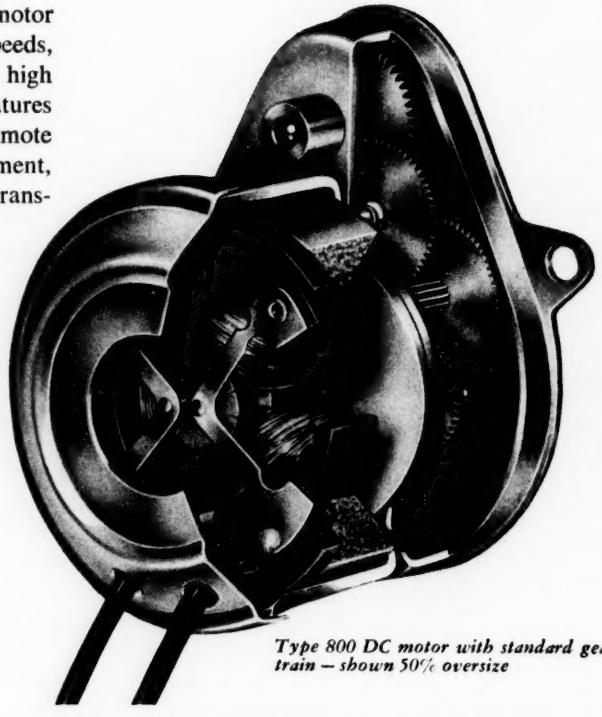
Write for Catalog E10-1

LIBRASCOPE

LIBRASCOPE, INC., 40 E. VERDUGO AVE., BURBANK, CALIF.
For more information circle 11 on inquiry card.

New high-torque low-current DC motor covers extended range of output speeds

The new Cramer Type 800 direct current motor offers an unusually wide range of output speeds, coupled with low current drain, high torque, high efficiency, and excellent speed stability. These features make it the ideal choice for timing devices, remote control equipment, recorders, signalling equipment, communications gear, displays, flashers, chart transports, and many other products.



Type 800 DC motor with standard gear train — shown 50% oversize

Wide Performance Range

Depending on requirements of speed, torque, and voltage, the rotor is wound to produce a basic motor speed of 960 to 3000 rpm. A gear train then reduces this to the speed required at the output shaft. Low rotor speeds result in lower current drain at all speed-torque combinations, but limit the torque available at the higher output speeds. Higher rotor speeds require a somewhat higher input current, but greatly increase the torque available at the higher output speeds.

The Table at lower right illustrates this flexibility of design, with a few examples from the virtually unlimited range of performance characteristics which it provides. Where very low input current is required, and the supply voltage does not exceed 12 volts, the use of the low-speed rotor will provide 30 oz. in. at speeds below 3 rpm and 0.5 oz. in. at 200 rpm. The higher speed rotors meet the requirements of higher input voltages, and provide greatly increased torque at the higher output speeds with only a moderate increase in current drain. The high-torque motor has the additional advantage of speed stability within 10% from no-load to full-load, at speeds below 5 rpm.

The examples given in the Table are for illustration only. By correct choice of rotor winding and gear ratio, an unlimited number of operating specifications can be established throughout the entire range shown. The motor is also available without gear train, for output torques of 0.1 to 0.6 oz. in. at speeds up to 3000 rpm.

OUTPUT SPEEDS WITH GEAR TRAINS	960 RPM ROTOR LOW INPUT CURRENT *(3 to 12 volts DC)*		3000 RPM ROTOR HIGH OUTPUT TORQUE *(3 to 30 volts DC)*	
	INPUT VOLT-AMPERES	OUTPUT TORQUE OZ. IN.	INPUT VOLT-AMPERES	OUTPUT TORQUE OZ. IN.
2 rpd	.16	30	.....	.....
1/6 rpm	.16	30	.56	30
3 rpm	.35	24	.64	30
10 rpm	.35	8.5	1.04	30
30 rpm	.35	3.0	1.72	21
60 rpm	.35	1.5	1.72	12
80 rpm	.35	1.1	1.72	8.5
200 rpm	.35	.5	1.72	3.5
900 rpm	.....	.....	1.90	.8

Typical Performance of Type 800 DC Motors for Minimum Input Current or Maximum Output Torque

Specifications

SPEEDS — 2 rpd to 900 rpm with gear train, 960 rpm to 3000 rpm without gear train.

TORQUE — 0.1 to 0.6 oz. in. without gear train, and to 30 oz. in. with gear train.

CURRENT DRAIN — as low as 30 milliamperes, depending on voltage, load and speed.

VOLTAGES — from 3 to 30 volts DC.

REVERSING OPERATION — with negligible speed difference, because of special motor design.

GEARS — precision-hobbed throughout, totally enclosed and with sealed-in lubricant.

For your free copy of informative Bulletin PB-800, write:

CRAMER CONTROLS
CORPORATION
Box 5, Centerbrook, Connecticut

For more information circle **12** on inquiry card.

to probe high-altitude, high-tem

. . . CEC's 5-122 Recording Oscillograph

permanently records 26 channels of data simultaneously (plus 2 reference traces) on film or paper

CEC'S 5-122 IS BUILT TO TAKE IT—to surpass the endurance of ordinary instrumentation. Compare this combination of environmental *operating* specifications with any oscillograph made: Temperature range from −65° to +250°F at altitudes to 120,000 feet . . . Will withstand a steady acceleration of 15 G's along any of its three major axes without interruption or deterioration of its performance . . . Operates in salt-sea and dust-laden atmospheres and in a relative humidity up to 100% at +122°F. . . Explosion-proof certification. . . Built-in vibration isolators provide firm protective support and eliminate the need for external shockmounts.

CRASH-RESISTANT MAGAZINE. The all-important record of test results is always secure in the 5-122's record magazine. This crash-resistant unit is engineered to withstand the same abuses as the oscillograph plus a shock of 200 G's for 4½ milliseconds.

NOTHING SACRIFICED FOR ENVIRONMENTAL SPECIFICATIONS — Standard features of the 5-122 include a writing speed of more than 12,000 ips . . . jump-speed selector . . . flash timing . . . 12 record speeds from 0.047 to 96 ips . . . automatic record identification . . . and provision for synchronous operation with an over-all data acquisition system. The 5-122 weighs only 80 lbs. fully loaded and is 11″ wide, 8″ high, 18½″ long.

For complete details, contact your nearest CEC sales and service office or write for Bulletin CEC 1585-X9.

MASTER TIMING UNIT supplies timing pulses to the 5-122. Can control up to 10 oscillographs and may be remotely located.

CONTROL UNIT contains all controls for operation of oscillograph. Is also ideal for remote operation.

HIGH-TEMPERATURE GALVANOMETERS — CEC High-Temperature Galvanometers guarantee high sensitivity and accuracy in ambient temperatures to 250°F for extended periods. Fluid and magnetically damped types cover frequencies from 0 to 3000 cps. Write for Bulletin CEC 1528-X15.

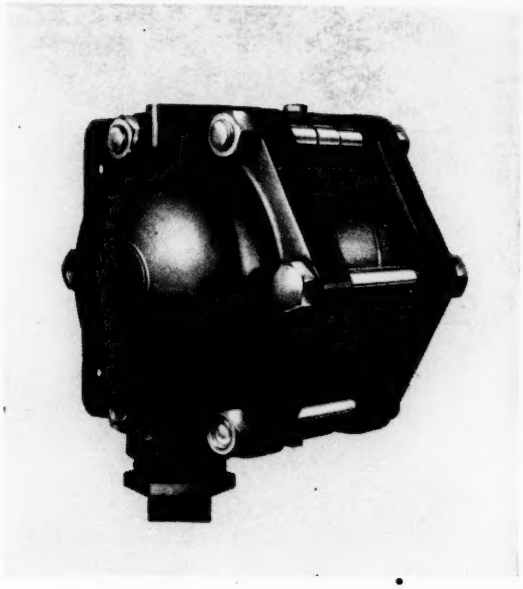
Consolidated Electrodynamics

300 North Sierra Madre Villa, Pasadena, California

OFFICES IN PRINCIPAL CITIES THROUGHOUT THE WORLD

For more information on Oscillographs circle **13**: Timing Units **14**: Control Units **15**: Galvanometers **16**.

NEW!



Honeywell Bellows Meter...

unequalled for accuracy, stability, versatility in flow and liquid level metering

The new Honeywell Bellows Flow Meter gives the better performance demanded by its potential users. It's the most advanced meter body available today, with important advantages never before found in flow and liquid level meters.

Some of its outstanding features:

Sensitive and accurate—Sensitive to within 0.05% of full scale ... calibrated accuracy ±0.5% of full scale.

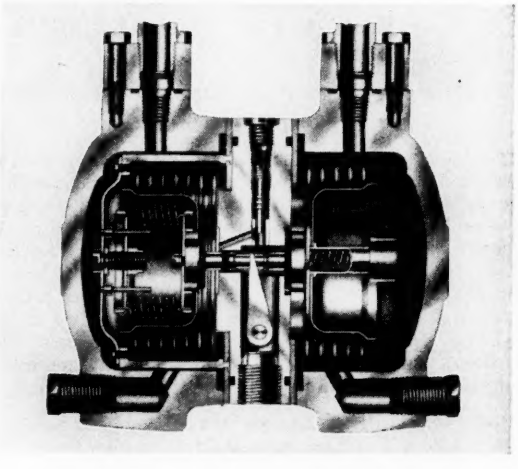
Leakproof—Between liquid fill and process fluid.

Automatically stabilized—Changes in meter body temperature or static pressure have no effect on output shaft position. The Honeywell Bellows Meter operates efficiently in surrounding temperatures of minus 40°F to plus 250°F.

Unmatched convenience features—Including fast range changing in the field ... connections for both horizontal and vertical piping ... quick calibration and adjustment ... easy cleaning and servicing.

High corrosion resistance—Seamless, stainless steel formed bellows give long, trouble-free service with virtually all process fluids.

Fast, effective damping adjustment—New type pulsation check with rectangular orifice enables essentially linear damping adjustment ... and you can adjust from outside the meter body during operation.



Models are available in many ranges, for both flow and liquid level measurement and control. Get details on *all* the features of the new Honeywell Bellows Meter by calling your nearby Honeywell field engineer today ... he's as near as your phone.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

REFERENCE DATA: Catalog C22-1

Honeywell

H HONEYWELL *First in Controls*

U. S. sales of instruments to Argentina in first nine months of 1957 were $1.4 million ($825 million industrial and process instruments, $580,000 scientific and lab instruments). 1956 total was $1.2 million; 1955 total was 1.9 million; 1954 total was $1.3 million. The 1955 total of $1.9 million included $1.6-million industrial and process instruments and $300,000 scientific instruments.

U. S. instrumentation exports to Paraguay in first nine months of 1957 were $125,000 ($31,000 scientific instruments and $94,000 industrial and process instruments). Total for 1956 was $47,000; for 1955 $22,000; for 1954 $39,000.

Instrumentation imports to Chile in 1955 were $1.94 million, including $530,000 from U. S., $500,000 from Germany, $130,000 from Britain, $680,000 from Switzerland, $118,000 from Sweden. American total included $340,000 scientific instruments and $190,000 industrial and process instruments.

U. S. instrumentation exports to Chile for first nine months of 1957 totalled $1.1 million ($517,000 scientific instruments and $581,000 industrial and process instruments). Total in 1954 was $1.06 million; in 1955 $250,000; in 1954 $598,000.

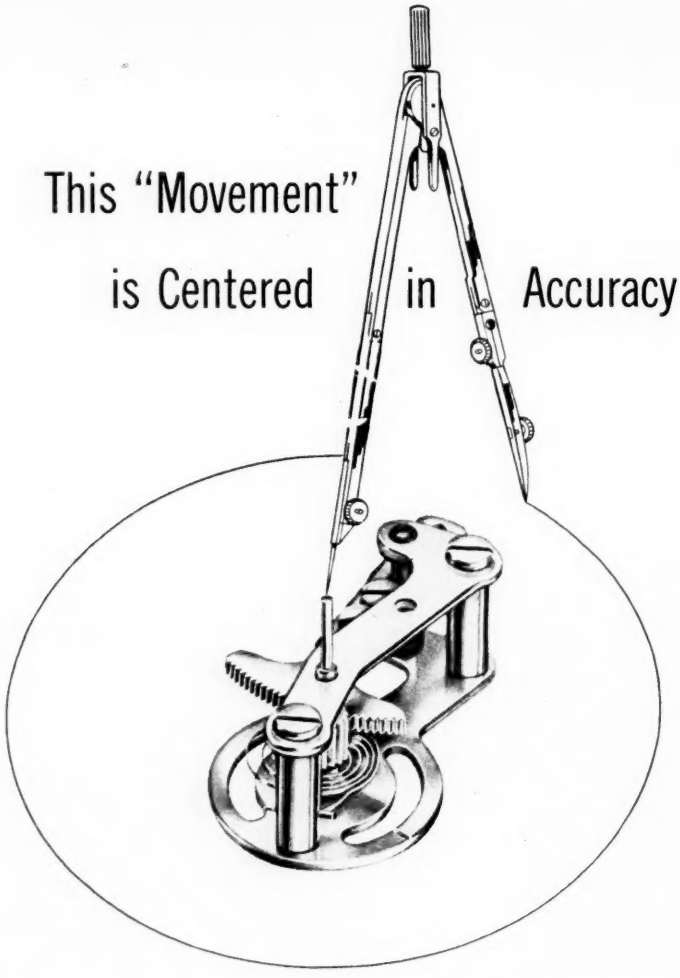
Process industry use of analog computers is increasing rapidly. In 1956, 24% of time charges of Electronic Associates' Princeton Computation center were to the process industries; in 1957 more than 42% were to the process industries--higher than any other industry, including aircraft.

At present there are about 15 general-purpose analog computer installations in the process industries, with a value in excess of $2 million.

1958 world market for nuclear instruments is expected to be $47 million according to Dr. Ernest H. Wakefield, president, Radiation Counter Labs., Inc. This includes $40-million market in U. S., $3-million in England, $2.5-million in Europe, $800,000 in Japan, $300,000 in Canada, and $400,000 in remainder of western nations.

Past 6 years have seen a fantastic 5%/year increase in efficiency in electric power generation via steam turbines, owing to larger units and higher inlet temperatures, reports Dr. Guy Suits of GE. But improvement rate for next 10 years will be about 1% to 1.5% because temperature and size limits have reached point of diminishing returns.

This "Movement" is Centered in Accuracy



The rotary movement in Ashcroft Duragauges has a geared center shaft on which the pointer is mounted. When pressure flexes the Bourdon tube, the pointer is always positively positioned. You can rely on the Duragauge for precise accuracy in measuring pressure no matter how severe the conditions of service.

Correct calibration is guaranteed: the one-piece link between movement and Bourdon tube prevents slippage or parting under tension. Recalibration is easy from front or rear. Universal adjustability permits uniformly graduated dials.

You can order Ashcroft Duragauges with all-stainless-steel movement or stainless steel with nylon bearings and pinion gear. A complete choice of Bourdon tube materials, pressure ranges, dial sizes and case designs and materials is available. Your industrial supply distributor will gladly help you select the best combination for your requirements. So, be certain of highest sustained accuracy, durability and economy – specify Ashcroft Duragauges.

Ashcroft Duragauge in Alumalife® case—a lifetime case made of special aluminum alloy.

MAXWELL M&M MANNING & MOORE INC. TRADE MARK

G1-58

ASHCROFT PRESSURE GAUGES

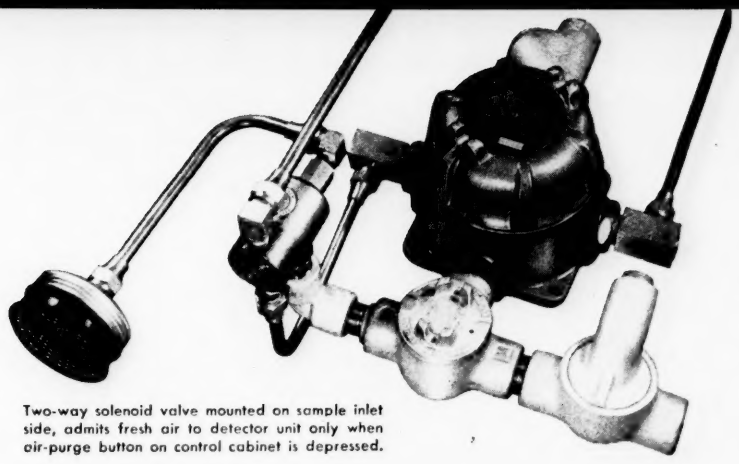
A product of

MANNING, MAXWELL & MOORE, INC.

Consolidated Ashcroft Hancock Division • Stratford, Connecticut

In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario

For more information circle **17** on inquiry card.



Two-way solenoid valve mounted on sample inlet side, admits fresh air to detector unit only when air-purge button on control cabinet is depressed.

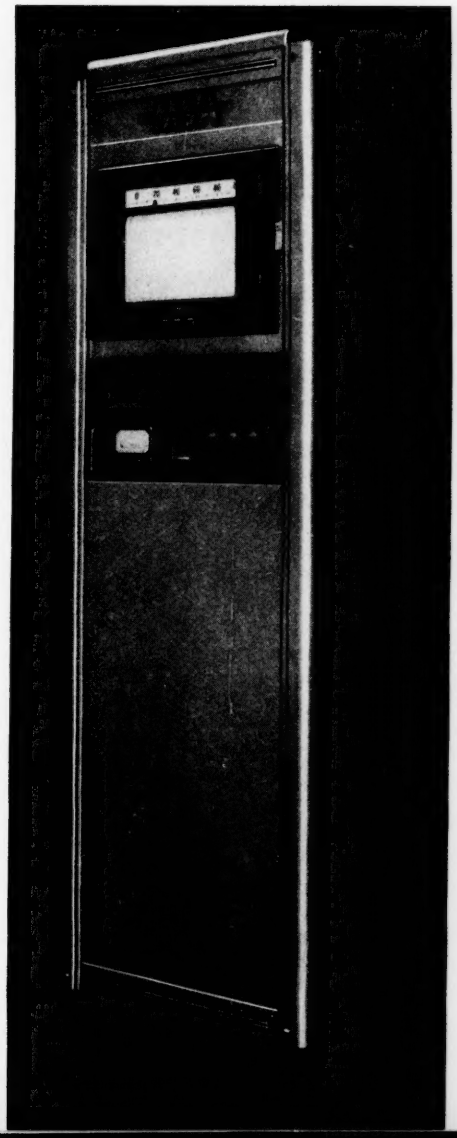
USING HIGH FLASH POINT SOLVENTS?

M-S-A® Remote Head Analyzers sample combustible vapors in elevated temperature areas such as coating ovens and drying ovens. And they do it reliably, accurately, and safely.

Combustible vapors in high temperature operations are often impossible to analyze at normal room temperature. The problem is: how to measure the sample without cooling and condensing the combustible vapors.

The M-S-A Remote Head solves this problem. Filament units are enclosed in an explosion-proof housing suitable for installation in Class 1, Group D hazardous areas. This unit may be placed in the oven or a high temperature area. This permits analysis at process temperatures without condensation of the vapors to be measured. Then, after passing through the filament chamber, the sample is allowed to cool and any condensate is trapped and disposed of, to prevent blockage of the vacuum line to the sample pump.

Where temperatures fluctuate—over a wide range in certain types of ovens—it is necessary to maintain a reasonably constant sample temperature during analysis. For this purpose, the Remote Head can be supplied with built-in, thermostatically controlled heaters to maintain a constant operating temperature within the Remote Head Assembly. This assures utmost reliability and accuracy under these sampling conditions.



An MSA Instrument Specialist would be happy to answer your specific questions on gas analysis equipment. Get in touch with him, soon. And write us for helpful new literature on the *M-S-A Remote Head Analyzer*.

INSTRUMENT DIVISION

Mine Safety Appliances Company

Pittsburgh 8, Pennsylvania

For more information circle **18** on inquiry card.

news

Russia to Exhibit Industrial Instruments at Automation Show!

MOSCOW, USSR—The Russian Chamber of Commerce, Moscow, has announced that it will exhibit a complete line of instruments and automatic control equipment for pressure, temperature, flow, liquid level, etc., at the Fourth International Automation Exposition, New York, June 9-13, 1958.

The exhibit will include electronic potentiometers, electrical measuring instruments, regulators and regulating devices, automatic analytical instruments and "automatic devices for some technological processes in the manufacture of instruments."

Whereas Russian observers have carefully monitored all American trade shows, this is the first time that the Soviet Union has placed its industrial and laboratory line of instruments on display in America.

NBS Semiannual Progress Report

WASHINGTON, D. C.—The semiannual report of the Office of Basic Instrumentation, National Bureau of Standards for the period ending June 30, 1957 reports on projects in the Basic Instrumentation Program.

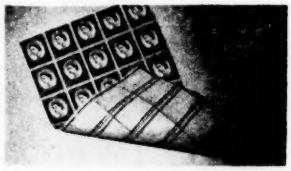
Projects in the various divisions include:

1. Survey of Voltage-Sensitive Devices (0103-40-2017) by F. K. Harris, emphasizing galvanometer techniques.
2. Improved Velocity Analyzer (0404-20-3066) by J. A. Simpson, on electron scattering in interaction with solids, electron velocity measurements, electron spectroscopy, etc.
3. Measurement of High-Energy X-ray Intensities (0411-20-3156) by J. S. Pruitt, using a specially designed calorimeter and comparing results with a total-absorption spectrometer.
4. Vibration Pickup Calibration (0601-30-3596) by Seymour Edelman, using a stroboscopic interferometer.
5. Microwave Measurements (9400-20-8902) by Glenn F. Engen, exploring application of electron-beam techniques.

Coming Next: Post-Office Automation

PITTSBURGH, PA.—Reports reaching us show that post-office automation is being tried in Great Britain, Canada, and in our own country.

• *Great Britain* is trying out a system in which postage stamps furnish the clue: Graphited, conductive ink is applied in stripes on the back which complete a circuit when bulk mail is placed in a special sorting and cancellation machine. Thus "high-priority" and "low-priority" mail can be distinguished. Acheson Colloids, Ltd.,



London, a subsidiary of Acheson Industries, Inc., Port Huron, perfected the ink which posed a variety of difficult problems.

• In *Canada* fluorescent material is being used to impregnate the stamps. An electronic printer is used to code the back of each envelope with a special code giving address information. The coded mail is sorted automatically on a conveyor system controlled by a computer. The system was demonstrated at the recent IRE Show in New York and is claimed to be the simplest so far devised. Codes chosen eventually can be used internationally.

• The *U. S. Post Office* is claimed to be working on a similar system (according to the IRE). Previous announcements by the National Bureau of Standards spoke of the development of prototype machines by NBS which will memorize the distribution scheme of a city and then be able to look up any address in the largest city in about 1/20th second.

TV Salutes Automation

NEW YORK, N. Y.—The field of Automation and instrument control of manufacturing will be saluted by Alex Dreier, noted radio and TV commentator, during a nationwide radio program Sunday, June 8, over NBC-

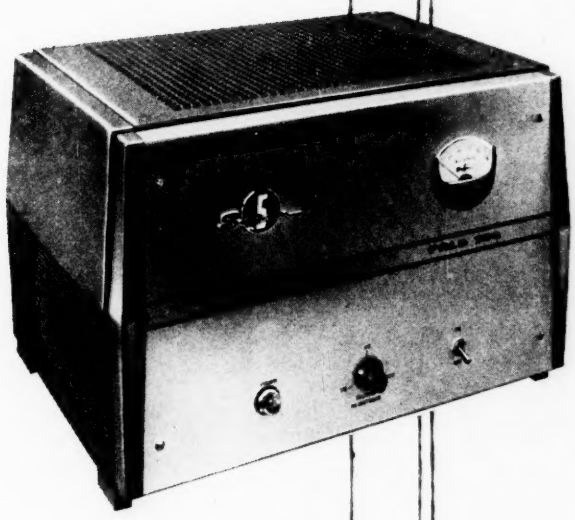
MONITOR. The program will be broadcast at 6:05 P.M., New York Time, over the entire NBC network of nearly 200 stations. Dreier's tribute will tie in with the Fourth International Automation Exposition which begins June 9 in New York City, and the concurrent International Automation Congress.

Continued on page 744

NEW AC REGULATOR

FAST RESPONSE—LOW DISTORTION

THE FRLD 750



The Only AC REGULATOR with Distortion LESS than 0.35% and Response Time LESS Than 1 cycle – and Regulation Accuracy Held Within ±0.25% for Line and Load Combined!

This *new* type of AC Regulator, the Sorensen FRLD 750, features the ability to reduce line distortion below 0.35%, with *exceptionally* fast response time. Transients caused by line or load changes are suppressed within less than one cycle.

Even when input distortion is above that of normal utility supply, output distortion is reduced by a factor of at least 8:1. The magnitude of transients – line or load – is likewise reduced by the same 8:1 factor.

The new FRLD 750 Regulator provides two output ranges . . . 0-750 and 0-1200 Volt Amps. The instrument weighs only 100 pounds, and dimensions are: 19 x 12¾ x 15⅞ inches. The cost of this new, high-performing close-regulating Sorensen development is good news too – only $825.

Get the complete story, or a demonstration of its high-level performance, by calling your Sorensen representative. Or wire or write for full technical details.

CONTROLLED POWER FOR RESEARCH AND INDUSTRY

SORENSEN & COMPANY, INC.
Richards Avenue, South Norwalk, Connecticut

In Europe, contact Sorensen-Ardag, Eichstrasse 29, Zurich, Switzerland, for all products including 50 cycle, 220 volt equipment

For more information circle **19** on inquiry card.

For ALL your dry battery needs

BURGESS

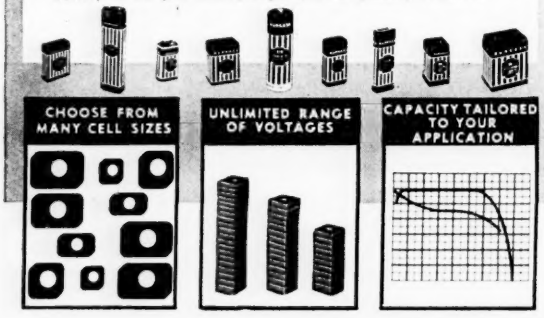
Serves You Better!

MOST COMPLETE LINE OF STANDARD BATTERIES

2 out of 3 industrial-electronic engineers specify Burgess Batteries! That's because the Burgess line of dry batteries is the most complete and dependable one-source line on the market! There's a Burgess Battery for almost every conceivable dry battery application. Choose from over 5,000 types already designed.

FREE DESIGN SERVICE FOR NEW APPLICATIONS

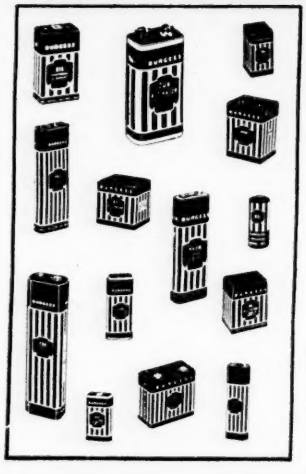
For those special applications, skilled Burgess Engineers offer you a FREE design consultation service. When your particular problem has been solved, Burgess will manufacture the exact battery to fit your needs, regardless of quantity required!



BURGESS *Exclusive* ***WAFER CELL CONSTRUCTION Gives Greatest Selection of Dry Batteries***

The revolutionary Wafer Cell offers a 30% increase in battery life at no increase in size. This exclusive Burgess construction consists of a sandwich of manganese dioxide mix between two flat electrodes of zinc and carbon with spots of hot silver wax applied to each exposed pole of the cell, allowing perfect electrical contacts throughout and almost complete absence of vibration. Cells are wrapped in Mylar film and packed in such modern materials as aluminum for compactness, long shelf life, exceptional service life, outstanding dependability.

HUNDREDS OF TYPES AVAILABLE



TRANSISTOR ACTIVATORS

Burgess Activator Batteries for transistor circuits are smaller and more compact in size. Yet they deliver 30% more power because of the patented "wafer-cell" construction. Burgess Activators give you compact power, uniform performance, longer shelf life . . . . all combined with modern packaging.

RESERVE BATTERIES

Can be stored dry for years. Activated only when immersed in water. No handling of dangerous electrolyte, no spilling or leaking! Wider range of efficient operating temperatures than any other type of battery.

Send for Engineering Data on Dry Batteries and Free Specifications Check Chart

BURGESS BATTERY COMPANY

FREEPORT, ILLINOIS

For more information circle **20** on inquiry card.

The broadcast is one of a series called "America on the Go," featuring Alex Dreier and sponsored by North American Van Lines, Inc., world-wide long-distance moving company with world headquarters at Fort Wayne, Indiana. Each of Dreier's Sunday broadcasts will salute an American industry or activity at the time of its annual trade show or convention.

News Bits

The Occupational Outlook, a quarterly published by the U. S. Department of Labor, **BUREAU OF LABOR STATISTICS,** describes current developments affecting employment trends. It includes information on Instrument workers. Available from U. S. Government Printing Office, Washington 25, D. C., $.30/copy.

BECKMAN INSTRUMENTS, System Div., has received a contract from Continental Oil Co. for an electronic computer-data processing system to sustain peak operational efficiency in a catalytic reformer producing some 10,000 barrels of high-octane gasoline a day. The system will be fully transistorized for maximum reliability. A similar system is being designed for Socony Mobil Oil Co.

B-I-F INDUSTRIES is using a "Micro Bus" as traveling showroom for selected products of the extensive Proportioneers line.

▲ B-I-F's "Micro Bus"

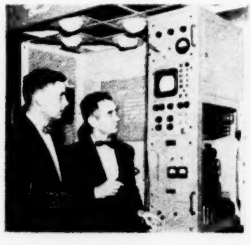
EAI at Brussels ►

The impressive U. S. Pavilion at the Brussels Worlds Fair contains an operating exhibition of digital computing equipment as well as an analog computer by **ELECTRONIC ASSOCIATES, INC.** The company was chosen because of its past support in international fairs and because of the reputation held by its products.

MANNING, MAXWELL & MOORE, Inc., Industrial Controls Div., is currently conducting another Customer Factory Course on its electronic process control system (American-Microsen). Petroleum, chemical, and other process industries are represented by 16 participants in the course.

PURDUE UNIVERSITY will hold an advanced short course in Quality Control by Statistical Methods June 10 to 20, 1958. Address Professor Irving W. Burr, Statistical Laboratory, Purdue University, Lafayette, Ind. for further information.

BENDIX AVIATION'S Cincinnati Div. has acquired manufacturing rights to the Chalk River transistorized 100-channel pulse-height analyzer, or "kicksorter."



FOR UNVARYING PERFORMANCE

PRECIOUS METAL CONTACTS . . . for long operating life and unvarying performance. Available in pure or alloyed forms of Silver, Platinum, Palladium, and Gold. These contacts provide extremely high resistance to atmospheric corrosion, deformation, arc erosion, sticking and metal transfer. They are supplied as wire, rod, sheet, and as fabricated forms.

Baker Contact Division, 207 Grant Avenue, East Newark, Harrison P. O., N. J.

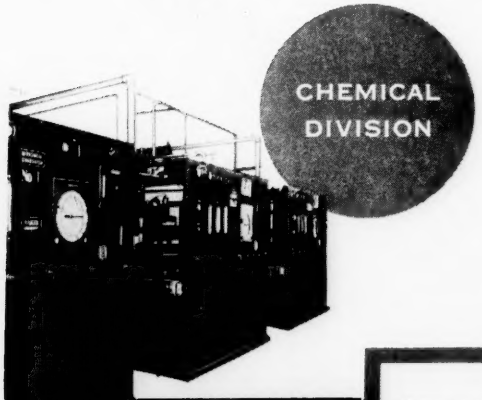
For more information on Precious Metal Contacts circle **21** on inquiry card.

FOR CORROSION-RESISTANT SURFACES

RHODIUM PLATING . . . an economical, hard, white, corrosion-resistant surface. Extremely well-suited for many electrical and electronic applications. Resistant to corrosive atmospheres, oxidation, arc erosion. Reduces wear on moving surfaces, assures low noise level for moving contacts, no oxide rectification, low and stable contact resistance. Ideal when a low-resistance, long wearing, oxide-free contact is required.

Chemical Division, 113 Astor Street, Newark 2, N. J.

For more information on Rhodium Plating circle **22** on inquiry card.



FOR PRODUCING NITROGEN

NITRONEAL® GAS GENERATOR . . . With a controllable hydrogen content—produces oxygen-free gas consisting of nitrogen, hydrogen and water vapor. Hydrogen content can be varied and maintained as desired between 0.5% and 25%. Economy is a major factor in this equipment. The cost of the nitrogen produced is found to be many times cheaper than an equal amount of cylinder nitrogen. Furthermore, the catalyst lasts indefinitely—maintenance costs are practically nil.

Chemical Division, 113 Astor Street, Newark 2, N. J.

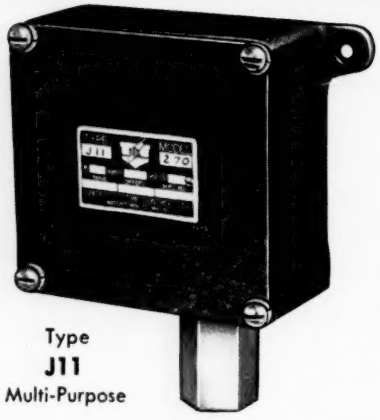
For more information on Gas Generators circle **23** on inquiry card.

ENGELHARD INDUSTRIES, INC.

113 ASTOR STREET
NEWARK 2, NEW JERSEY

Shock, vibration, and water resistant

PRESSURE CONTROL J11



Type
J11
Multi-Purpose

The Type J11 pressure control is an enclosed, precision built, rugged unit with water and shock resistant features. It is designed for surface mounting, has a cast bronze case, and has steel bearing surfaces and lock washers for applications involving shock or vibration.

Adjustable Pressure Ranges	various models cover ranges between limits of 0 to 600 psi and 0 to 30" Hg, Vac.
Switch Ratings	15 amps or 20 amps at 115 or 230 volts A.C.; D.C., manual reset, high ambient & other switches available upon specification
Switch Types	N.C., N.O., or double throw, no neutral position
Electrical Connections	Screw type terminals on switch are standard
On-Off Switch Differential	Fixed and uniform throughout specified range is standard
Mounting	¼" NPT female, brass fitting is standard
Variations	Design variations are available upon specification
Application	On industrial equipment and engine applications . . . marine, aircraft and special purpose

UNITED ELECTRIC *manufactures a complete line of temperature, pressure, and vacuum controls. For applications requiring custom-built units or modified standard units, call upon a UE application engineer for recommendations. Write for complete specification and pricing data on the Type J11. Similar data available on all other UE controls.*

United Electric Controls
COMPANY
85 SCHOOL STREET, WATERTOWN, MASS

For more information circle **24** on inquiry card.

ELECTRONIC ASSOCIATES, Inc. has shipped the first analog computer to a major Japanese research group, the Japanese Atomic Energy Commission.

BECKMAN INSTRUMENTS has shipped the process industries' first fully-transistorized computer-data processing system to Phillips Chemical Co.'s new unit at Sweeny, Texas. Peak efficiency is assured as well as optimum process control.

BDSA of Dept. of Commerce, Washington 25, D. C. has released a report *Precision Optical Components Study* by Louis A. Edelman. It includes a description of the optical and scientific instruments industry, and a statistical analysis of requirements vs capacity.

MINNEAPOLIS-HONEYWELL is supplying nuclear reactor simulators to four U. S. universities—U. of W. Va., U. of Minnesota, U. of Oklahoma, and Wayne State U. (Detroit).

MID-CENTURY INSTRUMATIC has been awarded a $152,810-contract for a major analog computer center by Naval Ordnance and Missile Test Station, China Lake, Calif. The facility will use three MC-5800 computers and accessories for evaluation of guided missile performance. The company's system can solve six-degree-of-freedom problems, including missile roll angle, yaw angle, pitch angle, angle of attack or attitude, and velocity.

AIEE committees have been set up to help companies exchange "programs"—coded statements of problems in digital computer "language". Thus far programs for 92 electric utility engineering problems have been made available.

VEEDER-ROOT recently held a sales conference to launch its new electronic counters, among them the new "Count-Pak" package (consisting of an electric eye, or photo-head pickup, and a counter) which accepts short pulses and records them. It is equipped with transistors and printed circuits and will count up to 3,000 units a minute.

BAUSCH & LOMB OPTICAL CO. this year is celebrating the 40th anniversary of manufacture of high grade optical glass.

MINE SAFETY APPLIANCES CO. furnished five specially-designed infrared gas and liquid analyzers for the launching of Explorer III into orbit. The five MSA LIRAS serve as continuous monitors of the hydrocarbon content of the liquid air, nitrogen and helium streams with which the missiles are fueled and pressurized. Should the hydrocarbon content of any of the streams approach a critical explosive point, the LIRAS shut down the operation.

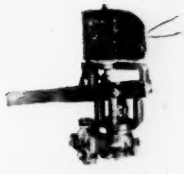
CONSOLIDATED ELECTRODYNAMICS and **HI-TEMP WIRES,** Inc. have signed a non-exclusive licensing agreement giving Hitemp the right to manufacture and market ceramic-coated wire using Ceramicite an entirely new ceramic-insulating material developed by CEC. Ceramicite-coated wire can retain insulating resistance at a continuous operating temperature of 1000° F.

CORROSION RESISTANT

2-way valves (requiring separate source operating pressure)

All of these basic types of valve operation are available from ASCO.

2-way valves fully automatic (do not require separate source operating pressure)



2-way and 3-way Manual Reset

3-way Fully Automatic

ASCO offers a complete selection of corrosion-resistant 2 and 3-way solenoid valves

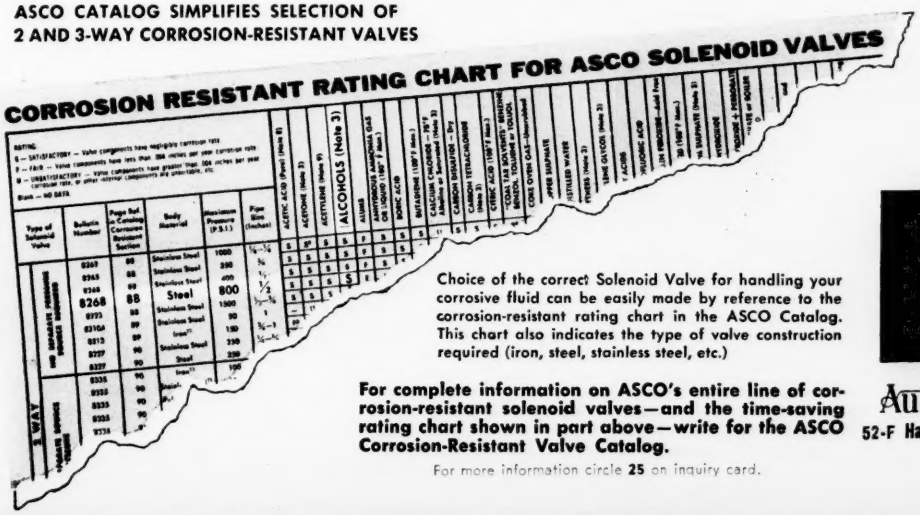
ASCO is the single source for a complete selection of Solenoid Valves capable of controlling corrosive gases and liquids.

Fully automatic or manual reset 2 and 3-way valves are available: 2-way valves can be obtained which are suitable for operating with or without a separate pressure source. Pipe sizes range from 1/8" to 6"; pressures to 1500 PSI, temperatures to 600 F. Catalog listed body materials include, for example, cast iron (with nickel alloy trim), cast steel (with stainless steel trim), stainless steel and monel – with rubber or glass linings. Many other types of body and trim material are available – or special valves can be designed to your specific application. All valves are available with standard, watertight or explosion proof solenoid enclosures, to meet any installation requirement.

Fluids handled range from sulfuric acid to sodium hydroxide – and include a variety of materials such as vegetable oils, distilled water, acetylene, coke oven gas, etc.

ASCO CATALOG SIMPLIFIES SELECTION OF 2 AND 3-WAY CORROSION-RESISTANT VALVES

CORROSION RESISTANT RATING CHART FOR ASCO SOLENOID VALVES



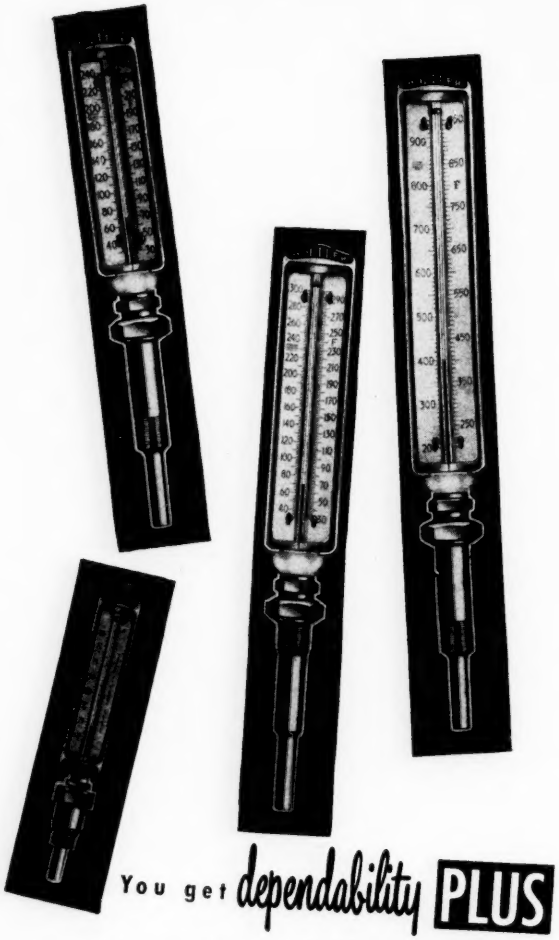
Choice of the correct Solenoid Valve for handling your corrosive fluid can be easily made by reference to the corrosion-resistant rating chart in the ASCO Catalog. This chart also indicates the type of valve construction required (iron, steel, stainless steel, etc.)

For complete information on ASCO's entire line of corrosion-resistant solenoid valves—and the time-saving rating chart shown in part above—write for the ASCO Corrosion-Resistant Valve Catalog.

ASCO®

Automatic Switch Co.
52-F Hanover Road, Florham Park, New Jersey
FRontier 7-4600

For more information circle **25** on inquiry card.



You get **dependability PLUS** in Moeller Industrial Thermometers

because our business has been the design and manufacture of temperature measuring instruments since 1867.

Moeller Industrial Thermometers are made in any form—straight angle, right or left side angles, reclined or inclined angles, in scale ranges of —120°F to plus 1125°F or in centigrade equivalents. Available in 5", 7", 9" and 12" scale sizes with plain stems, union connection stems and separable sockets in all stem lengths and alloys. *Mail the coupon today for detailed information.*

MOELLER INSTRUMENT COMPANY
132nd ST. and 89th AVE.
RICHMOND HILL 18, N. Y.
Representatives in Principal Cities

Gentlemen: Without obligation, please send me Moeller Catalog No. 150 on Industrial Thermometers.

NAME .....
FIRM .....
ADDRESS .....
CITY ..... ZONE ..... STATE .....

For more information circle **26** on inquiry card.

stock report

Any further information concerning any of the following issues may be obtained from the Research Department, Bache & Co., 36 Wall Street, New York 5, N. Y.

New York Stock Exchange:

Price Range For 1958 Thru 4/16/58

	High	Low	Price As of 4/16/58
ACF Industries	40 3/4	27 3/4	40 3/4
Aeroquip Corp.	22 7/8	16 7/8	18 3/4
Allis Chalmers	26 3/4	22 5/8	24
American Chain & Cable	45 3/4	39 1/2	43 7/8
American Machine & Foundry	37 7/8	32 1/4	35 1/8
American Machine & Metals	57 1/2	4 1/2	53
American Optical	39 1/8	26 1/8	37 3/8
American Tel. & Tel.	175 3/8	167 7/8	175
Beckman Instruments	25 3/4	20 1/4	21 3/8
Bell & Howell	56	42	55 3/4
Bendix Aviation	55	44 1/2	46 1/2
Boeing Airplane	41 7/8	34 1/8	39 1/2
Bullard	15 3/4	10	13 1/2
Bulova Watch	12 7/8	9 3/4	11
Burroughs	32 1/4	27 5/8	27 7/8
Carborundum	31 7/8	28 7/8	31
Cincinnati Milling Machine	34 1/2	27	34 1/4
Clevite	16 5/8	13 3/4	16 3/8
Columbia Broadcasting "A"	29 3/4	24 1/2	29 1/4
Consolidated Electrodynamics	31 1/4	27 7/8	31 1/2
Consolidated Electronics	25 1/2	19 1/2	25 1/4
Cornel Dubilier	15 1/2	12 7/8	12 3/4
Corning Glass	87 1/2	74 5/8	82
Curtiss-Wright	26 1/8	20 5/8	22 1/4
Cutler Hammer	46	40 1/2	42 1/2 - 43 (1)
Daystrom	35	30	31 1/4
Douglas Aircraft	74 7/8	54 1/2	56 3/8
Eastman Kodak	107 7/8	97 1/8	105 7/8
Eaton Manufacturing	48 1/4	38 1/2	43 5/8
Electric Auto Lite	28 3/8	25	27 1/4
Elgin Watch	9 1/4	7 3/4	7 3/4
Emerson Electric	34 1/8	29	33 1/8
Food Machinery & Chemical	56 1/2	47 1/2	48 5/8
Gearwell	24 1/8	20 1/2	23 1/2 - 24 (2)
Garrett	35 1/8	27	33 1/2
General Dynamics	63 3/4	55 1/4	57 1/8
General Electric	74 1/4	59	58 1/8
General Instrument	11 3/8	4 5/8	7 3/8
General Mills	70 7/8	60 1/4	70
General Precision Equipment	41	34 1/4	35
General Railway Signal	24 1/4	22 1/8	23 1/4
General Telephone	44 1/4	40 5/8	43 7/8
General Time	21 5/8	16 5/8	18 7/8
General Tire & Rubber	30	22 1/4	23 5/8
International Business Machines	435 3/4	400	434
International Tel. & Tel.	31 1/2	29 1/4	31
ITE Circuit Breaker	42 1/2	31 1/8	37 1/4 - 37 3/4 (1
Lockheed Aircraft	44 1/4	35 3/8	43 3/4
Litton Industries	43 1/8	36 1/8	42 3/8
Magnavox	36 1/4	30 1/4	35 3/4
Minneapolis-Honeywell	66 1/4	56	62 1/2
Minneapolis Mining & Manufacturing	52 1/2	43 1/2	50 3/8
Motorola	42 1/4	36 1/4	37
Mullory	26 3/4	24 1/8	24 3/4
National Acme	53 1/2	43 7/8	50 5/8
National Cash Register	58 1/8	50 1/2	54 3/4
North American Aviation	33 1/8	25 5/8	27 5/8
Northrop Aircraft	24 3/4	22 1/8	22 5/8
Otis Elevator	53 1/8	40 1/4	51 1/2
Philco	17 1/8	12 3/8	14 1/8
Radio Corp.of America	35	30 1/4	30 7/8
Raytheon	26 3/8	21 1/2	26
Reliance Electric	35	32	33 - 33 1/2 (2
Rheem Manufacturing	13 3/8	10 1/2	12 7/8
Robertshaw-Fulton	26 3/8	22 1/4	23 1/4
Royal-McBee	22	16	16 1/2
Sangamo Electric	34 1/4	32	32
Sperry Rand	20 5/8	17 5/8	17 1/2
Square D	24 5/8	21 1/8	22 1/4
Standard Coil Products	8 1/4	6	7 7/8
Starrett (L.S.)	54	37	40 1/4 - 54 (2
Stewart-Warner	32	29	30 1/4
Sylvania Electric	37 1/2	31 1/2	36
Tel Autograph	5 7/8	3 3/4	5 3/8
Texas Instruments	34	27 3/4	34
Thompson Products	55 1/4	42 3/8	44 1/2
Tung-Sol Electric	26 7/8	23 1/4	24 3/8-24 3/4 (1
Underwood Corp.	17 1/2	12 7/8	16
Union Carbide Corp.	98	81 3/8	84 5/8
United Shoe Machinery	43 3/8	32	40 7/8
Western Union	18 1/4	15	17 3/8
Westinghouse Air Brake	22 7/8	17 7/8	21
Westinghouse Electric	65 1/2	57 1/4	58 1/2
Worthington Corp.	51 3/4	45 1/4	46 1/2

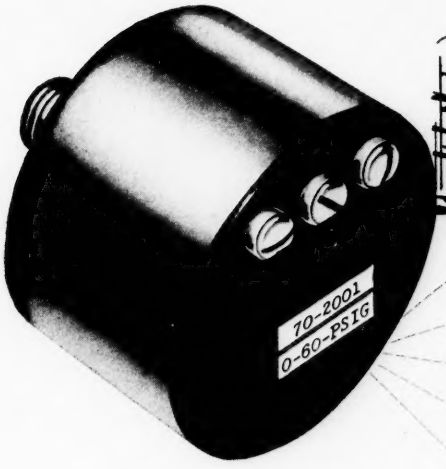
(1) Not Traded - Bid and Asked
(2) Not Traded - Bid and Asked

American Stock Exchange:

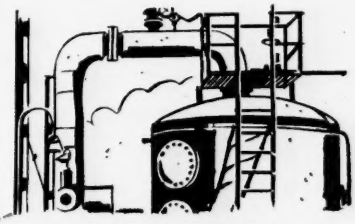
Price Range For 1958 - Thru 4/16/58

	High	Low	Price as of 4/16/58
American Meter	31 3/4	27 3/8	31 3/8
Arc Equipment	25 7/8	13 3/4	24 7/8
Barry Controls "B"	9 1/2	4 3/8	5 7/8 - 6¼ (1
Belock Instruments	10 1/8	7 3/8	9 7/8
Bruns Watch	6 7/8	5 1/4	5 1/4
Breeze Corp.	6 1/2	5 1/4	5 3/8
Clark Controller	17 7/8	14 7/8	16¾ - 16 7/8 (1
Claostat Mfg.	3 1/4	2 7/8	3 - 3 1/8 (1
Clary Corp.	4 1/4	2 7/8	3 5/8

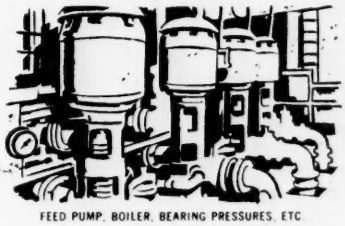
Continued on page 751



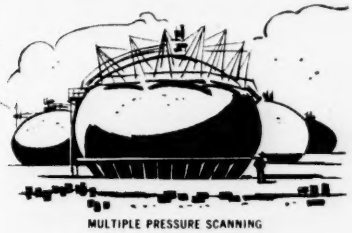
AIR, OIL, HYDRAULIC FLUID, STEAM, ETC.



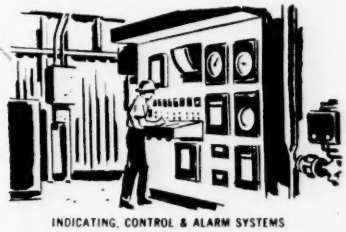
PIPELINE, TANK & PROCESSING



FEED PUMP, BOILER, BEARING PRESSURES, ETC.



MULTIPLE PRESSURE SCANNING



INDICATING, CONTROL & ALARM SYSTEMS

Compu-tran

PRESSURE TRANSMITTER

For Precise Pressure Measurement at Lower Cost

Compu-Tran quality and performance meet the requirements of chemical, petroleum and industrial processing—at a price as much as 25% less than similar devices! Look at these features:

Accuracies to ½% • Long Wear Life—Corrosion Resistant Models • Vacuum and Pressure Ranges from 0-15 to 0-3000 psi • Resistances from 300 to 5000 ohms • Response time full scale 50 milliseconds • Small 2¼" Size.

Compu-Tran pressure transmitter is a pressure pick-up which converts pressure inputs to exact proportional electrical equivalents. It monitors pressures with the same simplicity that a thermocouple monitors temperatures.

This IRC transducer is adaptable to any standard null balance potentiometer or scanner calibrated in millivolts; it can be converted to make its output compatible with other outputs feeding a recorder or indicator. Installation is simple and uses existing instrumentation and power supply.

High level signal is adequate to drive input of high speed analog-digital converter or for use in control, telemetering, etc. without adding a high gain amplifier. Millivolt Output Converter and other special features available.

Write for New Bulletin R-1a

IRC

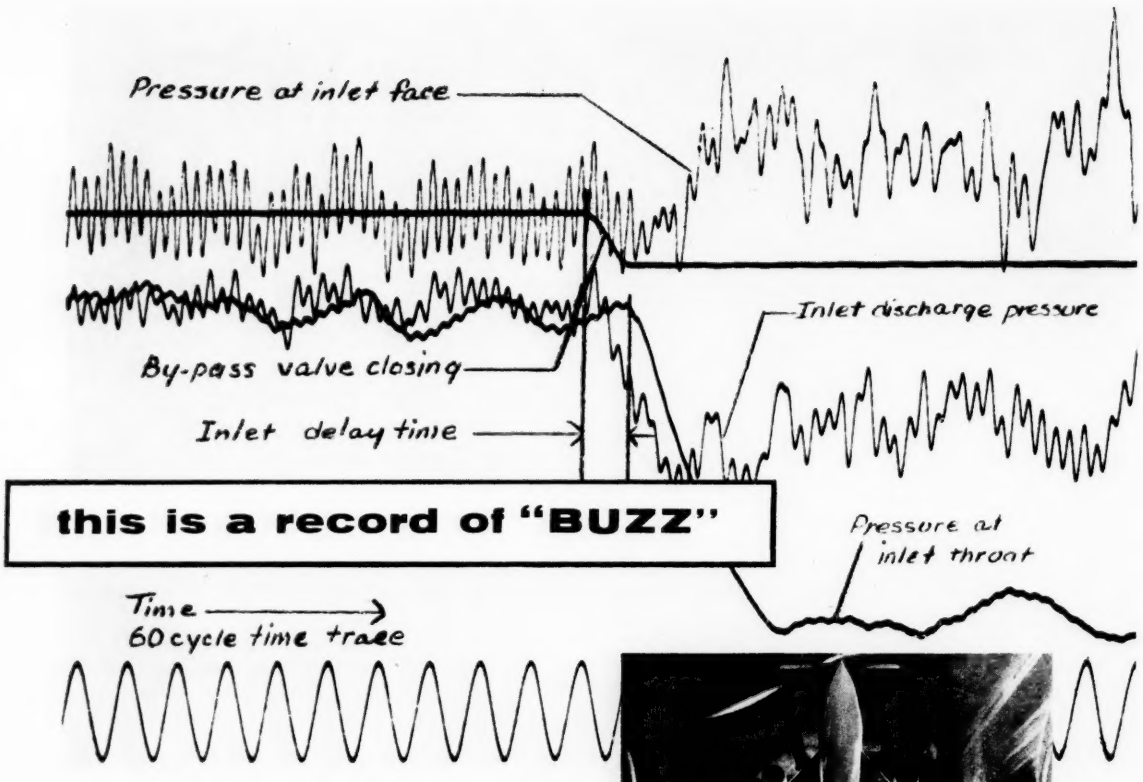
INTERNATIONAL RESISTANCE COMPANY

COMPUTER COMPONENTS DIVISION

Dept. 452, 401 N. Broad St., Philadelphia 8, Pa.

In Canada: International Resistance Co., Ltd., Toronto, Licensee

For more information circle **27** on inquiry card.

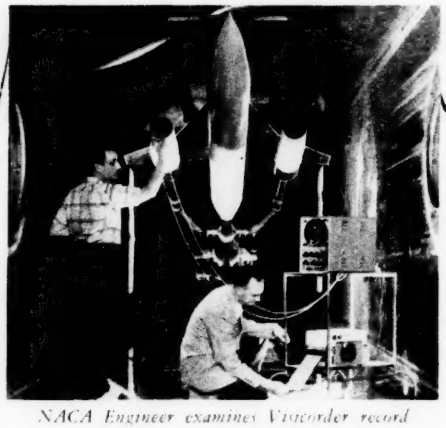


The Visicorder charts pressure fluctuations in a supersonic inlet

A Model 906 Honeywell Visicorder wrote this record of pressure fluctuations . . . "buzz" . . . for the National Advisory Committee for Aeronautics at the Lewis Flight Propulsion Laboratory in Cleveland. Buzz is the term used to describe unsteady variation in pressure and airflow characteristics of a supersonic aircraft or missile inlet.

The purpose of these Visicorder studies is to define the buzz-free operating limits of the inlet, and to provide the designer with structural load information in case the inlet is inadvertently caused to operate on buzz during flight. This is particularly important because inlet buzz can result in fluctuating structural loads of the order of 1000 psf. Depending on the inlet design, this could cause structural failure of the inlet and loss of the airplane.

High response pressure transducers are used to measure these fluctuating pressures and the resulting electrical signal is fed into the Visicorder. Records such as this are also necessary in the determination of the inlet dynamics such as delay time. This information is then used to design inlet control systems.



NACA Engineer examines Visicorder record

The HONEYWELL VISICORDER is the first high-frequency, high-sensitivity direct recording oscillograph. In laboratories and in the field everywhere, instantly-readable Visicorder records are pointing the way to new advances in product design, rocketry, computing, control, nucleonics . . . in any field where high speed variables are under study.

To record high frequency variables—and monitor them as they are recorded—use the Visicorder Oscillograph. Call your nearest Minneapolis-Honeywell Industrial Sales Office for a demonstration.

Honeywell

Heiland Division

Reference Data: Write for Visicorder Bulletin

Minneapolis-Honeywell Regulator Co., Industrial Products Group, Heiland Division, 5200 E. Evans Ave., Denver 22, Colorado

For more information circle **28** on inquiry card.

American Stock Exchange

Continued from page 392

Dumont Laboratories	4 5/8	5	5 1/2
Dynamics Corp. of America	4 1/8	4 7/8	5 1/4
Electronics Corp. of America	7 7/8	8 3/8	9
Hi-Tronics	3 1/8	3 5/8	4 1/4
Fairchild Camera & Instrument	24 5/8	29 1/2	29 7/8
Globe-Union	17 1/4	14 5/8	15 3/4
Hamilton Corp.	37 1/2	30 1/2	33 5/8
International Resistance	4 3/8	3 3/4	4
Lear, Inc.	5 1/4	4 1/4	5 1/2
National Research	15	13	14
Neptune Meter	23 7/8	19 1/2	23
New Haven Clock	1 1/4	7/8	1
Norden-Ketay	5 7/8	4 3/4	6 7/8
Nuclear Corp. of America "A"	2 1/2	2 1/8	2 1/4
Pneumatic Scale	25 1/4	18 1/2	20
Servo Corp. of America	5 1/8	3 3/4	4 1/8 - 4 3/8 (1)
Servomechanisms	8 1/8	6 5/8	7 7/8
Wallace & Tiernan	27 1/4	24 1/8	25 3/8-25 3/4(1)
Waltham Prec. Instrument Co.	2 1/2	1 13/16	2 1/8

(1) Not Traded - Bid and Asked

Over-The-Counter

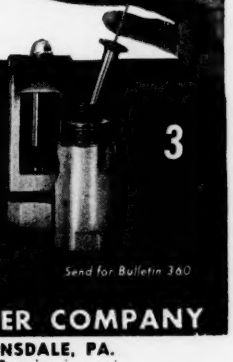
OVER-THE-COUNTER	Quotation as of 4/16/58 Bid	Asked
Aerovox Corp.	4 1/2	5
Aircraft Radio Corp.	17 3/4	18 3/4
Argus Corp.	17 1/4	18
Ritel-McCullough Corp.	26	27
Electronics Associates	35 1/2	36 3/4
Erie Resistor Corp.	6 1/8	6 5/8
G. M. Giannini	13 3/4	14 3/8
Industro Transistor	3 3/4	4 1/4
Liquidometer Corp.	6 1/4	7 1/4
W. L. Maxson	4 7/8	5 1/4
Penn Controls, Inc.	15	16
Speer Carbon, Inc.	23 3/4	24 3/4
Sprague Electric	29 1/2	30 3/4
Taylor Instrument	28	29 1/4
Telecomputing Corp.	3 7/8	4 3/8
Topp Industries	8 7/8	9 3/8
Varian Associates	15 1/2	15 7/8
Vitro Corp. of America	17	17 3/4

Now...a fully-Armoured FLOW INDICATOR simple as...

1 There's not a single stuffing box, yet this Model 3602 Armoured Flow Indicator handles pressures to 3000 psig; temperatures to 500° F. Eight ranges cover flows from 1.5 to 1200 GPH water. It's all metal with a positive-bond magnetic indicating follower and only 7 inches high.

2 Disassembly is the simplest ever... without removal from the line. Head is rotatable.

3 Cleaning is a snap...so are range changes. Metering plug and interchangeable orifice simply lift out. Plug seat automatically checks back flow.



Send for Bulletin 360

BROOKS ROTAMETER COMPANY

558 I STREET • LANSDALE, PA.

For more information circle **29** on inquiry card.

For Fast, Accurate Matching of Resistors, Capacitors, Inductors

SIE E-2 COMPARISON BRIDGE

1 ohm to 5 megohms, 500 mmfd to 2,000 mfd, 3 millihenrys to 10,000 henrys.

- Five meter ranges: 1%, 2.5%, 5% 10% and 25% difference readings at full scale.
- Accurate within 0.1% on 1% scale.
- Component differences of 1 part in 10,000 can be detected.
- Can be used with decade box for precise component measurements.

$185.00

SIE

SOUTHWESTERN INDUSTRIAL ELECTRONICS COMPANY

2831 Post Oak Road • P. O. Box 13058 • Houston 19, Texas

For more information circle **30** on inquiry card.

New VEEDER-ROOT Electronic "Count-Pak"*

A COMPLETE COUNTING PACKAGE!

High Speed . . . Electric Eye
. . . "Pulse Stretcher"
. . . Instant Reset

First of a new series of electric and electronic counting "packages" is this Model C "Count-Pak" . . . consisting of the new V-R instant-reset, high-speed (3,000 counts per minute) electric counter combined with a light source and photo cell.

Cell and light source can be adapted to any application . . . and are permanently assembled so vibration can't jar them out of focus. Pulses as short as .0002 seconds will actuate this device, which means that a ¼" object or space moving at 6,000 feet per minute will be counted. "Count-Pak" is transistorized throughout (no tubes) and utilizes printed circuits . . . double assurance of instant action and long trouble-free life. Rugged, compact case: 8¼" wide; 5¼" high; 6¼" deep. Panel includes pilot light, reset button, and power switch. *And prices are unexpectedly low.* Write:

EVERYONE CAN COUNT ON

Veeder-Root
INCORPORATED
HARTFORD 2, CONNECTICUT

Hartford, Conn. • Greenville, S. C. • Altoona, Pa. • Chicago
New York • Los Angeles • San Francisco • Montreal
Offices and Agents in Principal Cities

*Trade-mark registration applied for

For more information circle **31** on inquiry card.

a LOT of Relay in a little space

New Class "E" Relay measures only 2¼" x 1⅛" x 1³⁵⁄₆₄" minimum (2 springs) to 1²³⁄₃₂" (10 springs)

This latest Automatic Electric achievement compacts all the features of the famous Class "B" relay in minimum space and weight—with no sacrifice of quality or ruggedness.

LOOK AT THE IMPORTANT FEATURES THIS NEW CLASS "E" OFFERS:

• miniaturized; telephone-style base mounting for rear-connected wiring • heavy-thickness armature arms prevent loss of stroke with large pileups • heavy-duty backstop that won't break or wear out • adequate terminal clearances for easy wiring • long-life, lubricant-retaining bearing arranged to provide a visual check of the heel-piece airline setting without disturbing the adjustment • twin contacts standard; all springs bifurcated for maximum independence • sturdy, strain-relieved heelpiece insures stability of adjustment

Class "E" Relays are available in the following series:

EQA—Quick Acting **ESA**—Slow Acting*
ESO—Slow Operate **EFA**—Alternating Current
ESR—Slow Release **EMS**—Snap Action Contacts
*slow operate and slow release

Class "E" Relays can be supplied plug-mounted (with or without cover) or hermetically sealed (maximum 4 springs per pileup) in enclosure AE-3300.

• • •

For more information, call or write Automatic Electric Sales Corporation, Northlake, Illinois. *In Canada:* Automatic Electric Sales (Canada) Ltd., Toronto. *Offices in principal cities.*

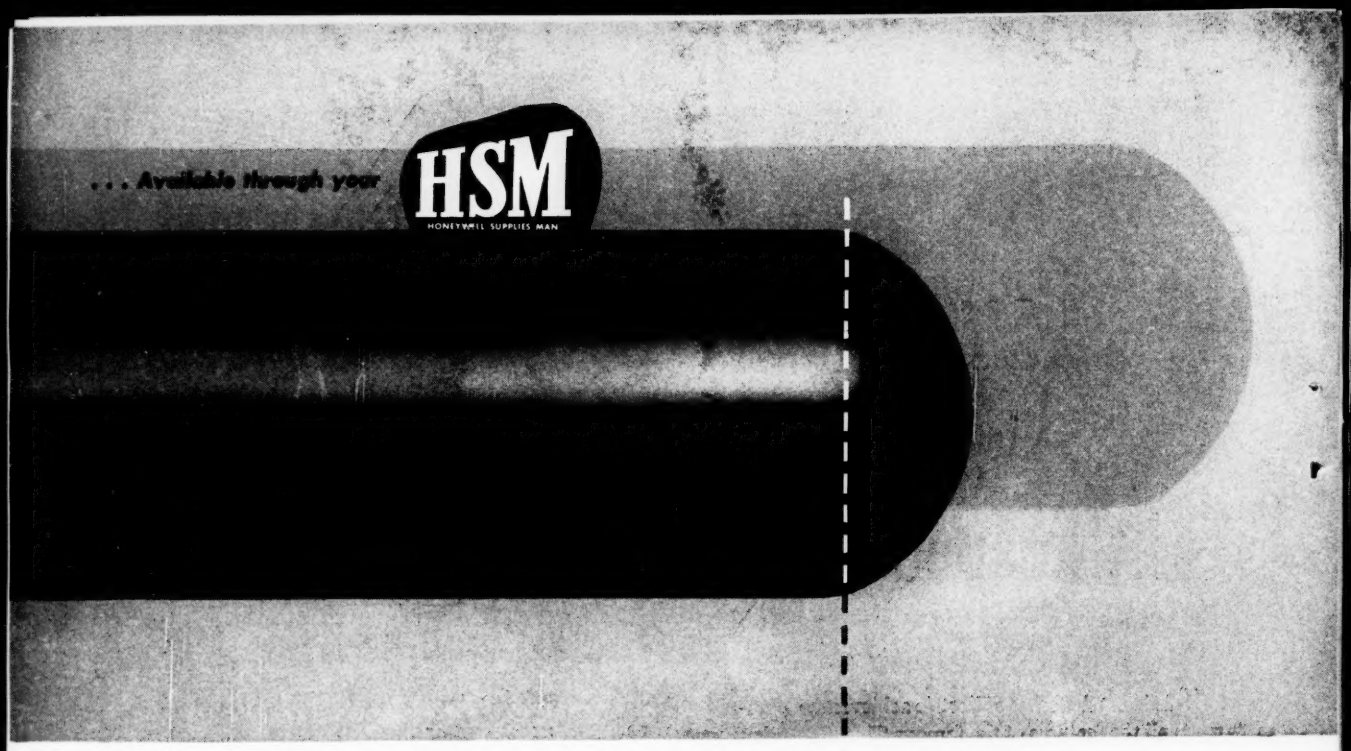
99% pure isn't pure enough — the relay iron we use at Automatic Electric must meet specifications of 99.8% purity, including, for example, carbon content limit of .02. To obtain highest magnetic permeability, material is treated for periods up to 7 hours in roller hearth annealing furnaces. Highest standards of quality control insure the well-known dependability of AE Relays and Switches.

AUTOMATIC ELECTRIC

Northlake, Illinois

Subsidiary of **GENERAL TELEPHONE**

For more information circle **57** on inquiry card.



SPUN-END

Protecting Tubes

for long, reliable thermocouple service

Spun-end construction adds extra quality to Honeywell closed-end drawn metal protecting tubes . . . at no increase in price.

These tubes keep thermocouple wires safe from corrosion and mechanical damage. They're made to withstand the toughest abuse you'll give them on the job.

Available in carbon steel, seamless steel, stainless steel, *Inconel**, *Resisteat***, nickel and wrought iron.

Order from your Honeywell Supplies Man. He can give you valuable assistance with your process control problems, as well as help you select pyrometer supplies. Call him today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

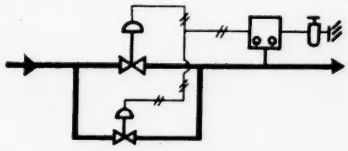
**Inconel is a trade name of the International Nickel Company.*
***Resisteat is a trade name of Minneapolis-Honeywell Regulator Co.*

Honeywell

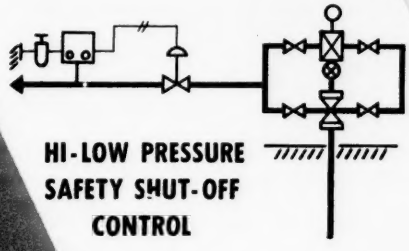
H HONEYWELL *First in Controls*

For Optimum Pressure Control, Specify BS&B 72-14 Pressure Controllers And Transmitters!

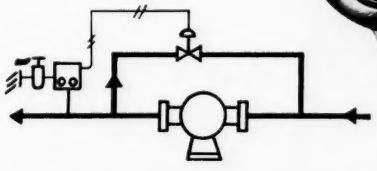
Proportional ★ On-Off ★ Differential Gap
Indicating Or Non-Indicating



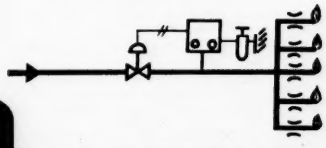
PRESSURE REDUCING CONTROL



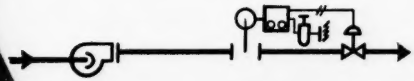
HI-LOW PRESSURE SAFETY SHUT-OFF CONTROL



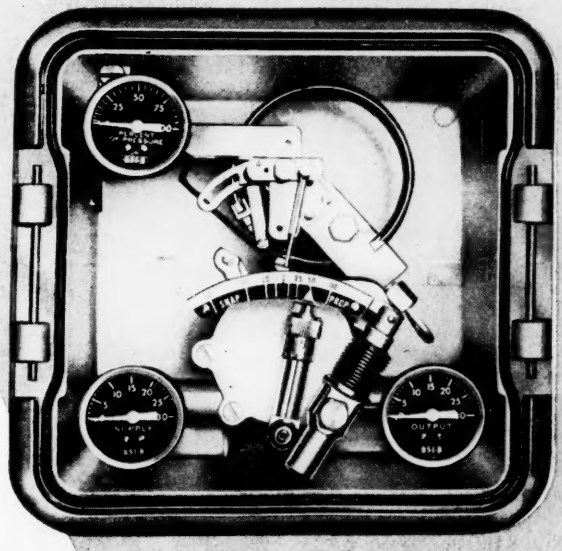
BACK PRESSURE CONTROL



LOW PRESSURE CONTROL



DIFFERENTIAL PRESSURE ...FLOW CONTROL



FEATURES OF POWER UNIT:

- Three-To-One High Capacity Relay
- Vibration Proof
- Push Button Cleanout
- Factory Calibrated Feed-Back Bellows
- Micrometer Adjustment

Ask Your BS&B Sales Engineer For Full Details, Or Write For Catalog 72-14.

OVER 60 YEARS
BS&B
ANOTHER EXAMPLE OF PRODUCT LEADERSHIP

BLACK, SIVALLS & BRYSON, INC.

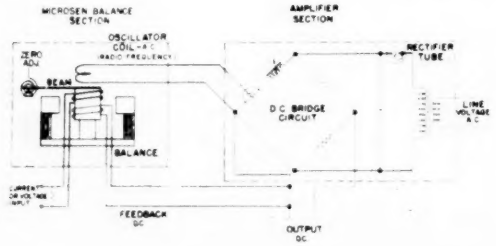
Controls Division, Dept. 4-V5
7500 East 12th Street
Kansas City 26, Missouri

For more information circle **32** on inquiry card.

briefs

Voltage/Current/Temperature Transmitters

The signal from the sensing element passes through a coil suspended from a mechanical balance beam into the field of a permanent magnet. Changing signal in the coil produces a magnetic force which deflects the beam. An oscillator coil, connected to the grid circuit of a vacuum tube amplifier, lies above the coil end of the beam. Beam deflection changes the inductance of the oscillator coil.



This alters the resistance of the amplifier tube and changes its plate current . . . A feedback coil, also suspended from the balance beam in the field of the magnet and counter-wound to the input coil, receives a portion of the output current. Force exerted by this feedback current on the beam opposes the force from the input signal and rebalances the beam at its original position . . . *(From new 4-page Bulletin TE710 included in binder containing 12 multi-page bulletins on "American Electronic Process Control", price lists, and glossary of control terms, Manning, Maxwell & Moore, Inc., Industrial Div., Stratford, Conn.)*

For this literature circle **276** on inquiry card.

Super Alloy Tubing

In order to distinguish Super Alloys from ordinary heat resistant alloys, we have arbitrarily defined Super Alloys as metals which have a 1000-hr stress-rupture strength at 1200°F at 25,000 psi minimum in combination with

Standard	*Special*	
AISI Type 316	19-9-DL[2]	Nimonic 80A[5]
A-286[3]	16-25-6[3]	Hastelloy X[7]
Inconel X[3]	Croloy 15-15N[4]	Hastelloy F[7]
Nichrome V[3]	Inconel 702[6]	Waspalloy
Hastelloy C[7]	Nimonic 75[5]	N-155[3]
Haynes 25[7]		

[1]Reg. U.S. Patent Office, Allegheny Ludlum Steel Corp.
[2]Reg. U.S. Patent Office, Universal Cyclops Steel Corp.
[3]Reg. U.S. Patent Office, Timken Roller Bearing Co.
[4]Patent applied for, Babcock & Wilcox Co.
[5]Reg. U.S. Patent Office, International Nickel Co.
[6]Reg. U.S. Patent Office, Driver-Harris Co.
[7]Reg. U.S. Patent Office, Haynes Stellite Co.
[8]Reg. U.S. Patent Office, Union Carbide Corp.

resistance to progressive scaling (oxidation) and other types of corrosion . . . Superior Tube Company is the pioneer producer of Super Alloys in small diameter tubing . . . Superior offers 15 different Super Alloy materials in commercial tubing . . . *(From new 10-page Bulletin 70, Superior Tube Company, Germantown Ave., Norristown, Penna.)*

For this literature circle **277** on inquiry card.

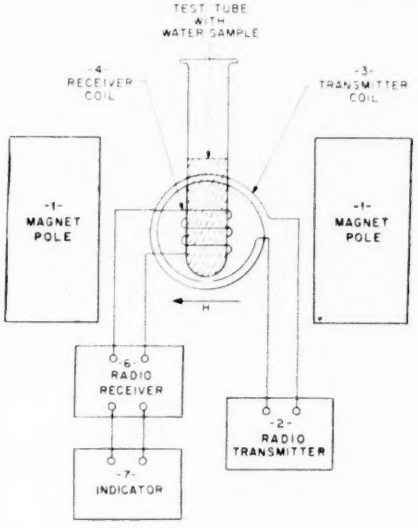
Bridge-Balance and Calibrating Units

Bridge-Balance and Calibrating Units . . . provide the means to balance, calibrate, control, and match strain gages and resistance-type transducers to oscillograph galvanometers and to provide for the direct recording, without amplifiers, of strains, loads, aircraft, power plants, ships, automotive vehicles, structures, etc. Seven basic models accommodating 6, 12, 18, and 24 channels, with manual and/or automatic calibration, and employing both shunt and series techniques (are available) . . . Remote control of the recording instrument in conjunction with the Bridge-Balance and Calibrating Unit can be effected. Automatic sequential calibration then follows each recording burst . . . *(From new 4-page Bulletin BBU 2-57, B & F Instruments, Inc., 4732 North Broad St., Phila. 41, Pa.)*

For this literature circle **278** on inquiry card.

High Resolution n-m-r Spectroscopy

n-m-r (Nuclear Magnetic Resonance) Spectroscopy is based on the fact that the various isotopes of the elements can be separately identified according to their differing nuclear gyromagnetic constants . . . The ratio of the magnetic moment value to the spin value, which is a constant for a given atomic nucleus, is called the gyromagnetic ratio for that particular nucleus . . .



A typical High Resolution ethyl-alcohol signal is . . . a plot of signal amplitude vs. external magnetic field displayed on a graphic recorder. By changing the resonant field and corresponding frequency to a new value, it would be found that the distance between the major peaks is linearly dependent upon the magnetic field, whereas the fine structure is field-independent. For example, in a field of 7000 gauss, the center peak of the CH_3 group and the single peak of the OH group would be separated by approximately 28 milligauss; at 3500 gauss, the separation would be 14 milligauss. On the other hand, the relative spacing of the sub-peaks would remain unchanged . . . *(From 8-page issue of "Radio-Frequency Spectroscopy" Vol. 1, No. 1., Varian Associates, 611 Hansen Way, Palo Alto., Calif.)*

For this literature circle **279** on inquiry card.

50 years

of making better instruments

May 1, 1958 marks the 50th anniversary of The Foxboro Company. Fifty years of leadership in process instrumentation. Fifty years of "either making a better instrument . . . or not making it at all."

On the next several pages are brief descriptions of current "Foxboro Firsts" that exemplify this basic company principle. Instruments that have contributed substantially to improved measurement and control throughout the process industries. Instruments that demonstrate what Foxboro leadership really means.

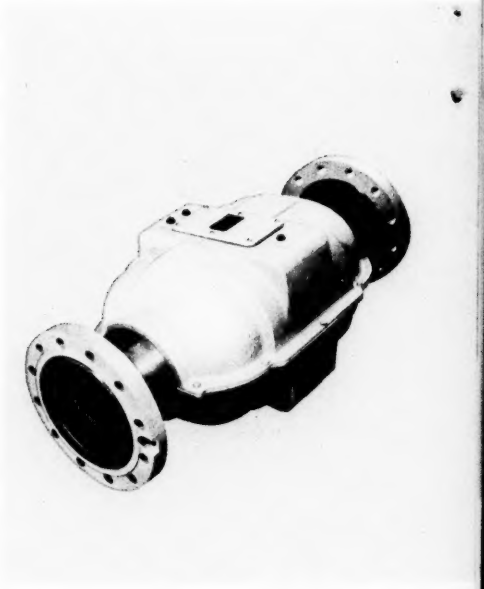
FOXBORO

REG. U.S. PAT. OFF.

CREATIVE DESIGN AND MANUFACTURE OF INSTRUMENTS
AND INSTRUMENT SYSTEMS FOR MEASURMENT AND CONTROL OF PROCESS VARIABLES.

Foxboro
makes
a better
instrument

—or Foxboro
doesn't
make it!



flow meter with
NO flow restrictions

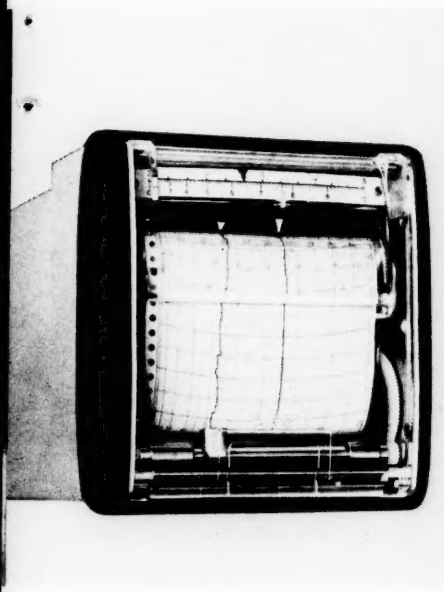
FOXBORO MAGNETIC
FLOW METER

The Foxboro Magnetic Flow Meter, first introduced in 1954, represents a completely new approach to liquid flow measurement . . . an approach that triumphs over such metering headaches as turbulence, loss of head, density variations, viscosity, temperature changes, and plugged measurement connections.

A magnetic field is maintained across the meter tube. Liquid flowing through this field creates a voltage proportional to velocity. Flush electrodes pick up and transmit this voltage to a Foxboro Dynalog Recorder.

Magnetic Flow Meters are available in pipe sizes from 1/10 inch to over 6 feet. Ideal for measuring flows of chemicals, pulp stocks, slurries, and many other viscous and corrosive liquids. Equally effective for clear liquids.

Write for detailed Bulletin 20-14B.



"full-scale" small-case instrument for centralized control

CONSOTROL* RECORDING CONTROL STATION

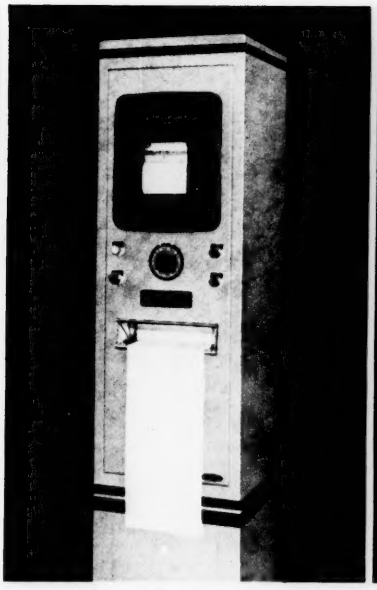
A small-case control station — compact yet with full-scale readability — is one of Foxboro's notable contributions to the centralized control field. The Consotrol Control Station, shown above, has a full-scale, 4-inch chart — the same length scale used on 12-inch circular chart instruments. Yet, four of these Consotrol Instruments can be panel-mounted where one conventional instrument used to go.

This Recording Control Station is a combination of the Consotrol Recorder and the Model 58 Controller, which mounts on the back of the recorder, or near the process.

With its unique "floating disc" design, and no slack diaphragms, the Model 58 quickly earned its reputation as the outstanding controller for the process industries.

Write for Bulletins 13-18A and 13-19.

*Reg. U.S. Pat. Off.



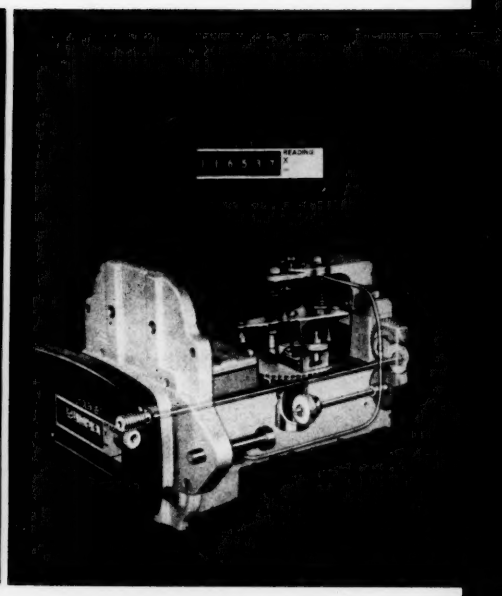
Radioisotopes harnessed for more sensitive measurement and control

FOXBORO SHEET WEIGHT PROFILER

This unique Foxboro development measures and records minute variations in the weight of paper and other web or sheeted materials. Measurement is made automatically by feeding a sample between a radioactive source and an ionization chamber detector. The amount of radiation passing through the sheet into the detector provides a deviation record of the weight of the sheet. This important quality-control measurement is far more rapid and accurate than was possible by any previous method.

The Sheet Weight Profiler is a typical example of how Foxboro engineers turn scientific advancements into better instruments for industry.

For full details, send for Bulletin PD 105-3.



continuous, pneumatic flow totalizing

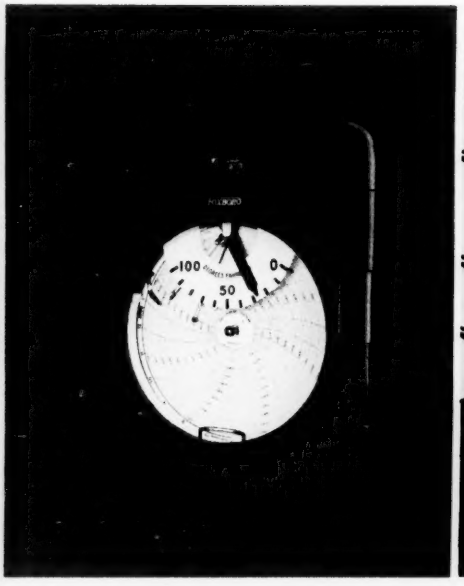
FOXBORO FLYBALL INTEGRATOR

An instrument that counts fluid flow — continuously! That's the achievement of Foxboro's unique "Flyball Integrator."

This totalizer completely eliminates conventional machined cams. Instead, a 3-15 psi air signal from a differential-pressure type flow transmitter is continuously balanced against the centrifugal force of a pneumatically driven turbine. Result — direct reading of actual flow units on the instrument counter. No converters — no intermittent increments.

Because it provides precise linear, continuous integration, the Flyball Integrator is ideal for the accounting of all process fluids and plant services.

For complete details, write for Bulletin 13-23.



"the potentiometer that has NO slidewire"

DYNALOG*
ELECTRONIC RECORDERS
AND CONTROLLERS

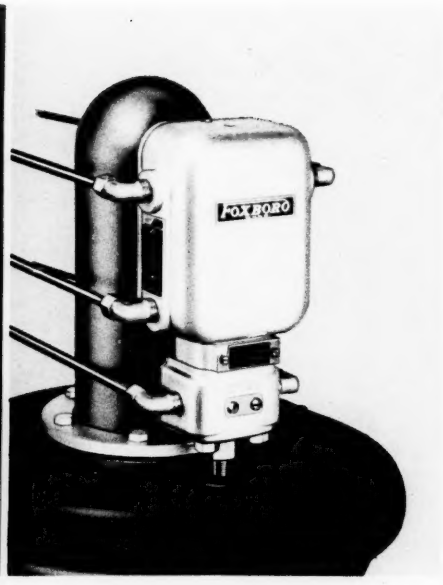
Measurement of process variables advanced radically with the development of Dynalog instruments.

These electronic instruments give stepless, continuous balancing, using a friction-free air capacitor instead of the conventional slidewire. There are no high-speed moving parts, no dry cells to replace, no interruptions even for automatic standardizing . . . and no lubrication. Dynalogs combine highest accuracy, sensitivity, and speed of response with unequaled freedom from maintenance.

Resistance, EMF, and capacitance type Dynalog Instruments are available for measuring and controlling temperature, pressure, flow, pH, conductivity, capacity, and many other process variables.

Write for Bulletin 20-10.

*Reg. U.S. Pat. Off.



new dynamic response in flow control . . .

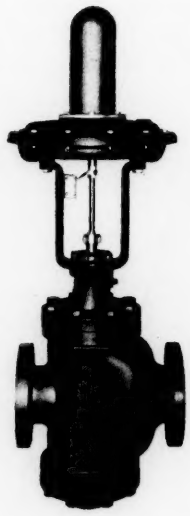
FOXBORO VALVE-MOUNTED
CONTROLLER

Controller-to-valve transmission lag is completely eliminated by this instrument, assuring unsurpassed speed of response — control that's precise, dynamic, smooth.

The M/59 is the *only* pneumatic receiver-controller specifically designed for direct mounting on the control valve motor. This unique force-balance controller has only two moving parts. There's nothing to align, nothing to wear out. A flexure-strip fulcrum eliminates friction and wear of conventional pivots . . . eliminates "conventional" maintenance.

Used with a flow transmitter, the M/59 gives live-action close-coupled response even when the operating panel is as much as 1,000 feet away.

For full information, write for detailed Bulletin 470.



control valve performance matched to control instruments

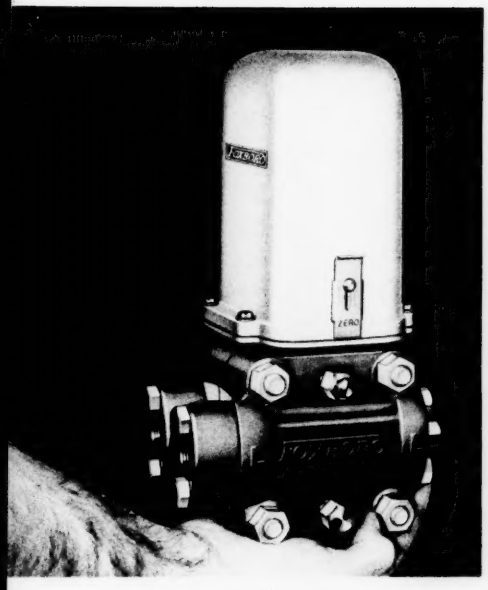
FOXBORO STABILFLO
CONTROL VALVES

Originally the control valve was considered the weak link in any pneumatic control system. Then Foxboro designed the air-operated Stabilflo control valve, the first valve with wide range, equal percentage V-port design.

These valves give precise, repeatable response for every change in control signal. They have equal percentage flow characteristics with a rangeability of 50 to 1 . . . so essential for maximum performance from proportional controllers.

One of the most copied designs in the industry today, Foxboro Stabilflo Valves are a processor's unqualified assurance of perfectly integrated pneumatic control systems.

For full details, write for Bulletin 5C-10.



differential pressure transmitter unequaled in accuracy, stability, and performance

FOXBORO
d/p CELL* TRANSMITTER

Now and then, a manufacturer develops a product so superior in every respect that it becomes the "standard" for its industry. Such a product is the Foxboro d/p Cell Transmitter.

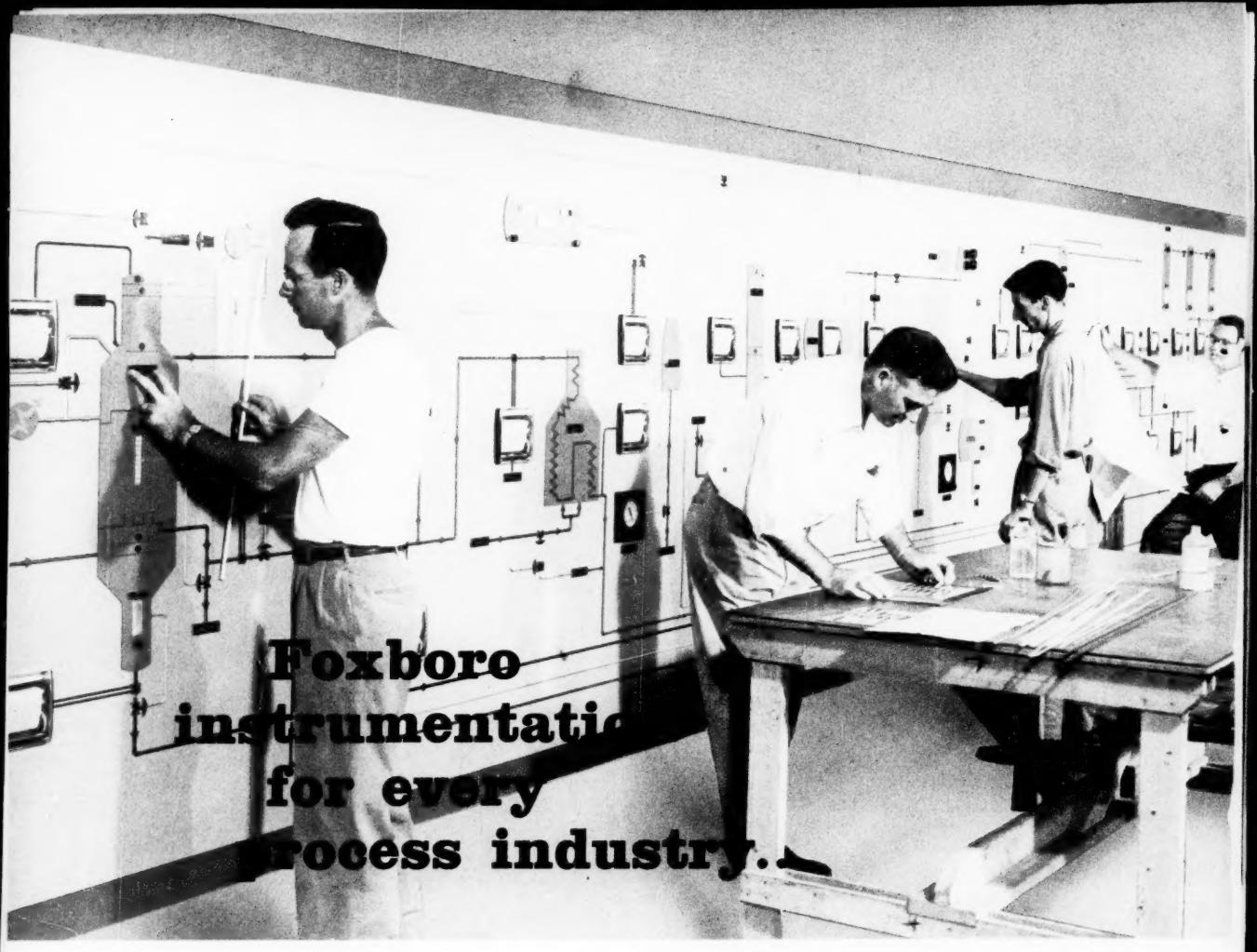
Pioneered 10 years ago, these differential pressure transmitters have established new standards of performance in flow measurement and control. Today, over 75,000 are in use—more than the total of all other makes put together.

d/p Cell Transmitters are now also available for liquid level control; measurement and control of extremely small flows; comparison of process and sample fluids; strain gauge systems; electronic inductive systems; for processes involving high static pressures, or elevated ranges. **Write for Bulletin 13-11A.**

*Reg. U.S. Pat. Off.

Foxboro makes a better instrument

—or Foxboro doesn't make it!



INDICATORS
RECORDERS
CONTROLLERS

for

air weight	humidity	resistance, electric
btu	liquid analysis	sheet moisture
capacitance	liquid level	sheet weight
compression	load	specific gravity
concentration, solution	moisture content	speed
conductivity, solution	motion	strain
consistency	motor load	stress
current—a-c, d-c	operation, schedule	temperature
density	operation, time	tension
dew point	oxidation-reduction potential	thrust
displacement	pH	torque
drag	position	vacuum
flow	power, electric	viscosity
force	pressure	voltage
gas analysis		weight

FOXBORO

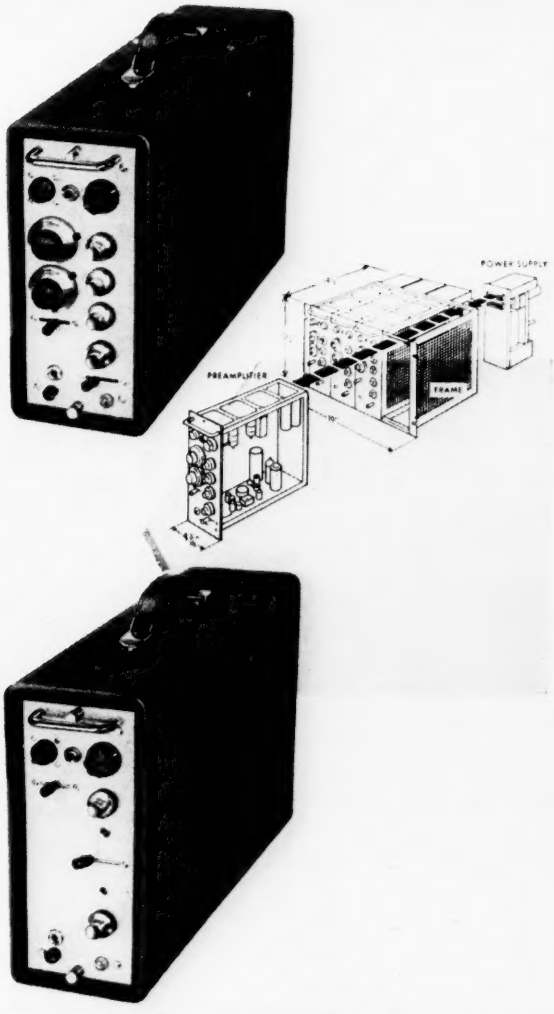
REG. U.S. PAT. OFF.

THE FOXBORO COMPANY, 54 NEPONSET AVENUE, FOXBORO, MASS., U. S. A.

greater **VERSATILITY . . . RELIABILITY . . . COMPACTNESS**

MODEL 450-1100 CARRIER PREAMPLIFIER

Carrier Freq. — 2400 cps (std.); 600, 1200, 4800 cps optional
Carrier Exc. — approx. 4.5 5 volts, depending on transducer imped.
Transducer Imped. — 100 ohms min. - 1000 ohms max.
Input Imped. — approx. 2500 ohms, incl. zero sup. ckt.
Sensitivity — 100 uv rms from transducer (output imped. 1000 ohms or less) gives 1 volt at output under max. output loading
Output — preferred circuit: between one active cathode and one reference cathode alternate circuit: between active cathode and ground
Output Voltage Capabilities — (a) ±3 volts into 2200 ohms min. load
(b) ±6 volts into 5000 ohms load
(c) ±7.5 volts open ckt
Output Linearity — better than 0.2%, for (a) above
Output Impedance — approx. 1000 ohms, preferred ckt., 500 ohms alternate output ckt.
Freq. Response — 3 db at 20% of carrier freq.
Zero Suppression — can suppress 0 to 100% of transducer output (either sense via switch)
Power Req. — 115 volts, 50-400 cps, approx. 30 watts
All data subject to change without notice.



SANBORN
450 SERIES
UNIT PREAMPLIFIERS
. . . FOR DRIVING OPTICAL OSCILLOGRAPHS
. . . TAPE RECORDERS
. . . 'SCOPES

Here is amplifier design that gives you *wider* usefulness, *improved* performance and a *choice* of packaging, in reduced size and weight. Individually in portable cases, or as four-unit modules for standard 19" racks, with their own power supplies, Sanborn "450" Preamplifiers can be used with a variety of popular optical oscillographs, tape recorders, oscilloscopes or other indicating devices. The 450-1100 is a carrier amplifier-demodulator with calibrated zero suppression, for measuring strain, pressure, velocity, flow, temperature, displacement, etc. with a strain gage bridge, resistance or reactance transducer, or differential transformer. For differential input measurements, the 450-1800 provides the wide range of an AC amplifier and DC stability of a chopper, in a design featuring low noise, low drift and high gain. The 1800's usefulness is increased by a choice of models: *1800*, with high current output amplifier (±2.5 v, ±50 ma), position control, and zero suppression; *1800A*, same as 1800 but without zero suppression; *1800S*, with single-ended output amplifier, delivers ±2.5 volts at ±1 ma, linearity 0.1% full scale, 30 kc bandwidth, zero suppression and position controls; *1800SA*, same as 1800S except without zero suppression.

Investigate the many exclusive advantages these and other Sanborn "450" Preamplifiers offer your work. Call your local Sanborn Engineering Representative or write the Industrial Division in Waltham.

SANBORN COMPANY
Industrial Division
175 Wyman Street, Waltham 54, Mass.

MODEL 450-1800 TRUE DIFFERENTIAL DC PREAMPLIFIER

Input — Impedance: 200,000 ohms differentially between terminals (balanced) or 100,000 ohms each input lead to gnd. (single-ended)
Common mode rejection: at DC, 100 db; to 60 cps, 94 db; 400 cps, 80 db.
Equiv. input drift: ±2 uv for 24 hours
Equiv. input noise: 5 uv peak to peak (0-10 cps), 20 uv (0-1000 cps), 50 uv (0-30 kc)
Zero suppression, polarity pos. or neg. Ranges 0-100 mv and 0-1 volt. Accuracy 1% of full scale range.

Output — *Low Power Circuit:* (in all models)
Output appears between two cathodes as true push pull signal.
Common mode level of cathodes ±0.2 volts with respect to ground.
Output capability: ±3 volts into 5000 ohms
±10 volts open circuit
Zero position control not active for this output
Freq. response: 3 db down at 30 kc
Linearity: 0.1%
Gain: Fixed steps 1000, 500, 200, 100, 50, 20
Gain Accuracy 0.5% for D.C.
Smooth gain control covers range between fixed steps

High Power Circuit: (1800 and 1800A)
Output appears between two emitters as true push pull signal.
Common mode level of emitters ±2.5 volts with respect to ground.
Preferred load: 50 ohms
Output: ±2.5 volts, ±50 ma
Freq. response: 3 db down at 15 kc
Linearity: 0.5%
Zero position control is operative for high power output ckt.

Single-ended Output Circuit: (1800S & 1800SA)
Output appears as single-ended signal between emitter and amplifier chassis.
Load 2200 ohms, min.
Output ±2.5 volts
Freq. response: 3 db down at 30 kc
Linearity: 0.1%

Power Req. — 115 volts, 60 cps, approx. 50 watts

For more information circle **34** on inquiry card.

"DIMENSIONEERED"
for GREATER Cv!

Compare
DeZurik
CONTROL VALVES
with any
other!

	DeZURIK CONTROL VALVES	TYPICAL SINGLE SEAT DIAPHRAGM CONTROL VALVE	TYPICAL SAUNDERS BODY CONTROL VALVE
1"	33	18	13
1½"	74	38	40
2"	148	58	55
3"	330	115	180
4"	560	197	370
6"	1180	405	810

DeZurik Control Valves offer more in other ways, too. Their low cost design makes it possible to furnish them *with a positioner* at a cost very often *less* than an ordinary valve *without positioner!* And check these features:

Excellent control characteristics

Straight thru flow reduces erosion and turbulence

Rotary stem seal eliminates stem leakage

Absolutely dead-tight shut-off

DeZurik Control Valves are available in sizes ½" thru 20" in Semi Steel, Steel, Bronze, Acid Resisting Bronze, Stainless Steel, Alloy 20, Hastelloy, Rubber-Lined and many other materials. See the DeZurik representative in your area or write for details.

DeZURIK
CORPORATION
SARTELL, MINNESOTA

For more information circle **35** on inquiry card.

BRIEFS—CONTINUED

Transac S-2000

Central Computer:

Transac S-2000 handles commercial, engineering and scientific data—linear programming, simulation, data logging.

1. Average operations per second (including memory access): a) arithmetic (fixed point), addition and subtraction 60,000; multiplication 26,000; division 17,000. b). Comparisons 83,000.

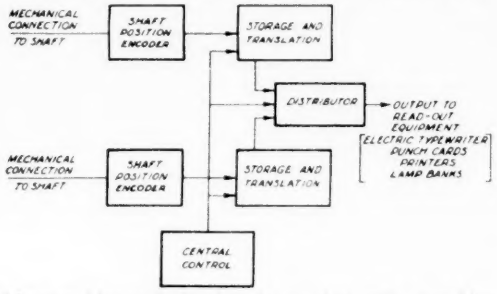
2. Memory capacity: a) Basic core storage unit—4,096 words (32,768 alpha numeric characters). b) Expandable to 65,536 words (524,288 alpha numeric characters) in units of 4,096 words.

3. Internal characteristics—central computer a) Binary —parallel—asynchronous. b) Fixed point (floating point optional). c) Word length—48 binary digits . . . (*From new 4-page Bulletin "Transac S-2000" Philco Corp., Government and Industrial Division, 4700 Wissahickon Ave., Phila. 44, Pa.*)

For this literature circle **280** on inquiry card.

Angular-Position Encoders and Systems

In the Series 31 encoders, Type 31A is designed to resolve a complete revolution of a shaft (360°) into 1000 parts (000 to 999). Types 31B, 31C and 31D encoders are designed to resolve into 1000 parts (000 to 999) for L & N, Brown and Bristol SBP recorders with a full scale angular rotation of 324, 320 and 336 degrees respectively. All of these types are equipped with encoder discs of non-



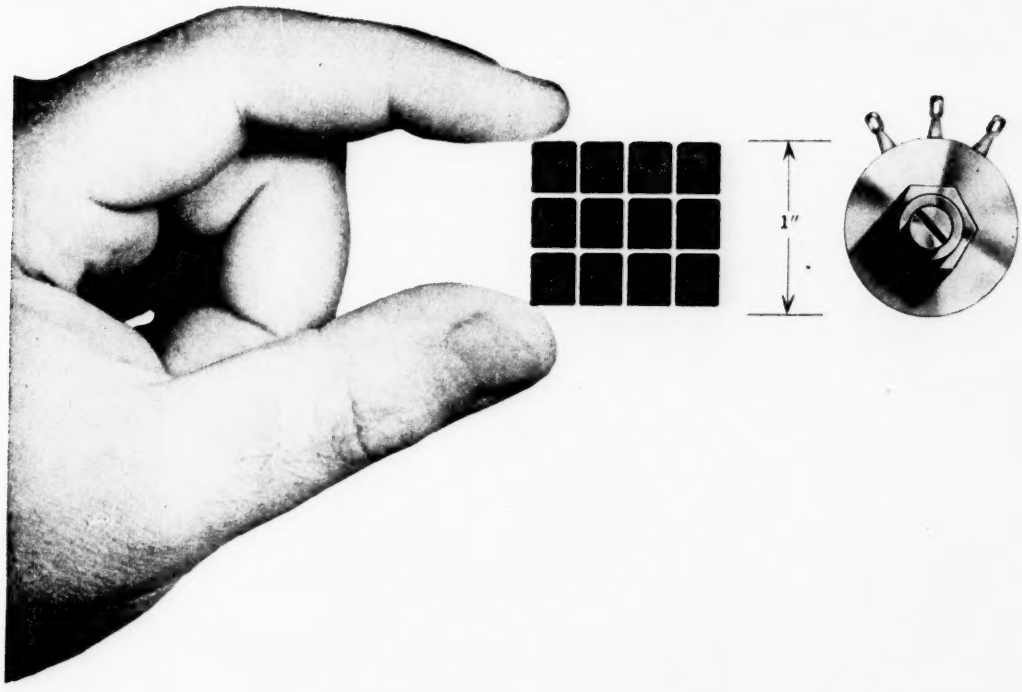
ambiguous binary-decimal code so that only one binary digit changes at a time in transition from one digitized position to the adjacent ones . . . To accommodate "on the fly" as well as stationary shaft readout, the information of the disc is first transferred to a storage unit. This is done by "pulsing" the common line of the encoder disc, and the data is held in storage until readout is completed . . . (*From new 4-page Bulletin Series 31, Wang Laboratories, Inc., 37 Hurley St., Cambridge 41, Mass.*)

For this literature circle **281** on inquiry card.

CeramiKouple

"CeramiKouple" is a metal-sheated, ceramic-insulated thermocouple. It withstands high temperatures, corrosive atmosphere and other conditions much longer than conventional thermocouples . . . does not even require a protecting well in many applications. "CeramiKouple" slips easily into previously inaccessible areas, responds quickly to temperature changes . . . "CeramiKouple" consists of quality thermocouple wire surrounded by pure aluminum-oxide or magnesium-oxide insulation and encased in a metal sheath of stainless steel or other durable metal. Depending upon what metal sheathing is used, it offers excellent resistance to chemicals, moisture, petroleum products, atomic radiation or abrasion . . . (*From new 8-page Bulletin GB-8, E. C. Smith Manufacturing Co., Forrest and Hector, Conshohocken, Penna.*)

For this literature circle **282** on inquiry card.



FIT 12 OF THESE RECTANGULAR POTENTIOMETERS IN A PANEL AREA OF 1 SQUARE INCH!

You can pack 12 Bourns TRIMPOT® potentiometers in the 1-square-inch area occupied by the average single-turn rotary.

Fit the TRIMPOT into corners—between components—flat against a chassis or printed circuit board. Mount them individually or in stacked assemblies. Any way you use them—Bourns potentiometers save space!

You can adjust Bourns potentiometers more accurately, too. The 25-turn screw-actuated mechanism gives you 9000° of rotation instead of 270°. Circuit balancing and adjusting is easier, faster. Repeatability is assured every time. Furthermore, adjustments are self-locking—shock, vibration and acceleration have no effect!

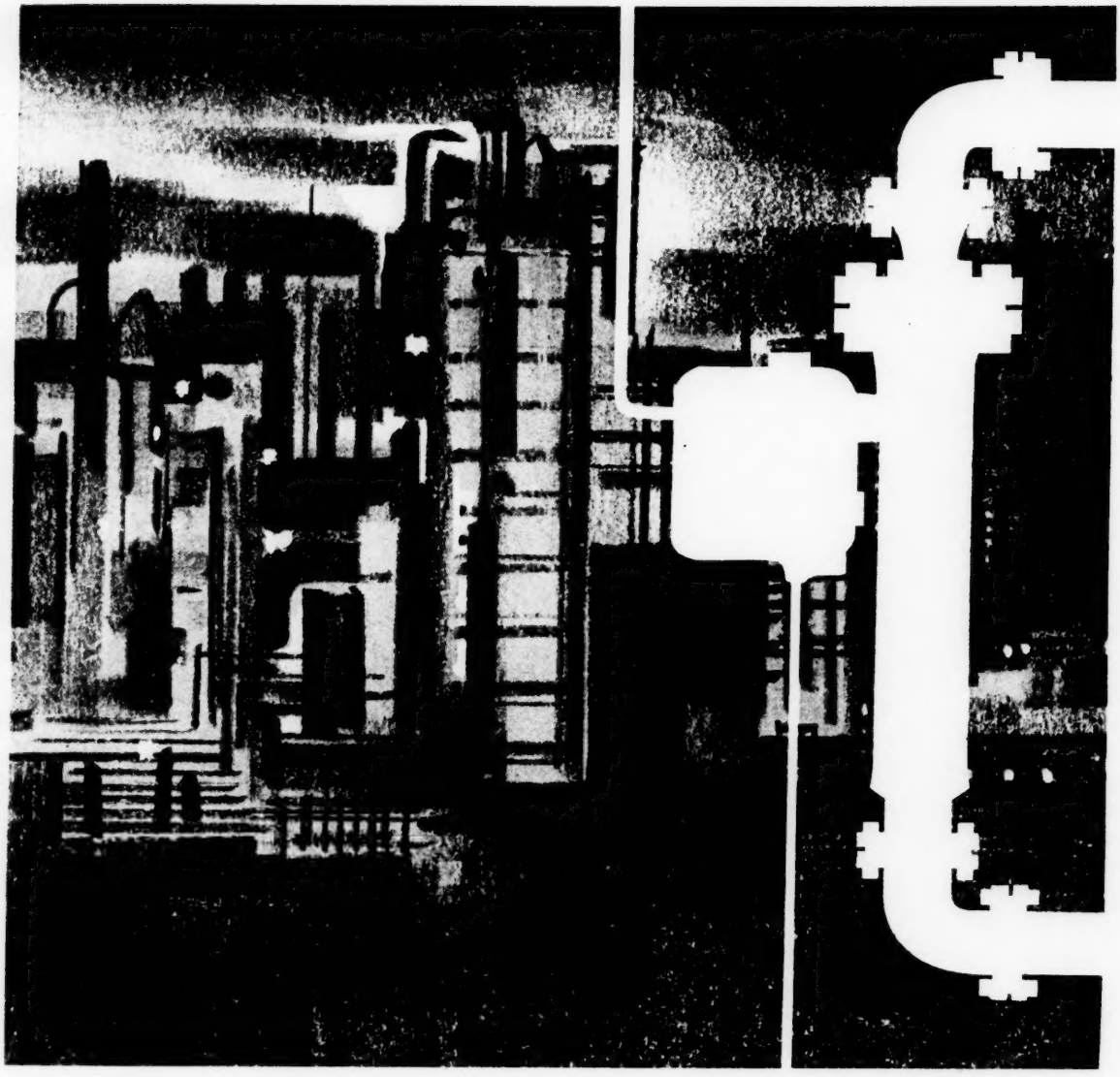
Write for new Model Summary Brochure

BOURNS
Laboratories, Inc.

P. O. Box 2112-A • Riverside, California

ORIGINATORS OF TRIMPOT® AND TRIMIT®
PIONEERS IN POTENTIOMETER TRANSDUCERS FOR POSITION, PRESSURE AND ACCELERATION

For more information circle **36** on inquiry card.



Fisher Level-Trols—universally accepted in the power and process industries

High in sensitivity and accuracy! For full float range operation the Fisher Level-Trol is factory calibrated or zero adjusted to produce an accurate 3 to 15 psi or 6 to 30 psi signal output. Designed, engineered and universally accepted for most liquid level control, liquid level indication and interface control problems. Has simple liquid level adjustment indicating dial—combined pneumatic proportional band and specific gravity adjustment. Heavy-duty built—easy to operate—simple to service. Available with cage units for external mounting or internal top or side flange mounting with float sizes from 14" to 120".

Write for Bulletin F4A for full details.

IF IT FLOWS THROUGH PIPE ANYWHERE IN THE WORLD... CHANCES ARE IT'S CONTROLLED BY...

FISHER GOVERNOR COMPANY

Marshalltown, Iowa / Woodstock, Ontario / London, England

FISHER® Controls

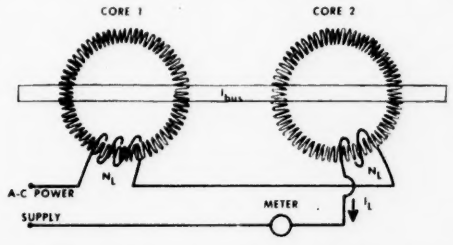
SINCE 1880

For more information circle **37** on inquiry card.

BRIEFS —CONTINUED

Transductors

Transductors are used for measurement of large amounts of direct current although they are electrically isolated from the current carrying conductor. Because they also provide a high level of signal output—unlike shunts—these transductors can control as well as measure . . . Essentially a pair of saturable reactors, the Control transductor consists of two wound "Orthonol" cores connected

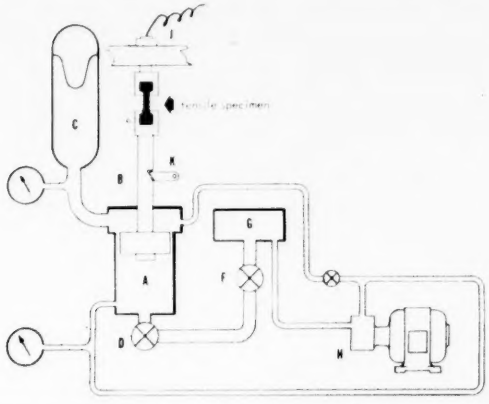


in series. The bus bar or cable which carries the direct current passes through the center of the transductor and acts as a single turn control winding. Although not connected electrically to the d-c circuit, the transductor gives an output in convenient current ranges linearly proportional to the direct current. The output is an alternating current which can be converted to d-c by rectifiers . . . (*From new 16-page Catalog T-10, Control, a Div. of Magnetics, Inc., Butler, Penna.*)

For this literature circle **283** on inquiry card.

High-Rate Deformation Tester

High rate tester, Model 625A, (allows) testing at deformation rates comparable to those the product actually encounters in use . . . . (and) . . . . provides a completely calibrated stress-strain record of the deformation of a specimen at rates as high as 6000 inches per minute . . . . During the test the electrical output of the wire



strain transducer (J), which is proportional to the stress in the sample, is applied to the vertical axis of a cathode-ray oscillograph. The linear motion potentiometer fastened to the piston rod B puts out an electrical signal proportional to the strain in the sample as the load is applied, and is applied to the horizontal axis of the oscillograph. The resulting light spot movement traces a complete stress-strain record for the sample under test . . . . (*From new 2-page Bulletin 625-1, Allegany Instrument Co., Inc., 1091 Wills Mountain, Cumberland, Md.*)

For this literature circle **284** on inquiry card.

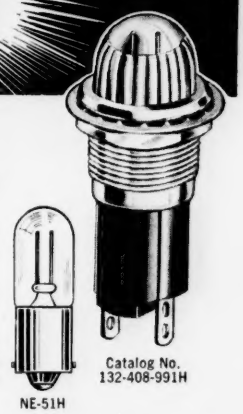
Now...

DIALCO Pilot Lights

with Built-in Resistor (18,000 ohms)
(a patented DIALCO feature)

and the NEW High Brightness Neon Glow Lamp NE-51H

A New Advance in Pilot Light Design by DIALCO:



Three basic advantages are incorporated in this series of DIALCO assemblies: (1) *Built-in resistor* for direct use on 125 to 250 volt circuits . . . (2) *New plastic lens* designed to give attractive *"halo"* effect . . . (3) New High Brightness Neon Glow Lamp *NE-51H*. This lamp may be operated at about 3 times the level of current that may be applied to the standard lamp, and it will produce 8 times as much light—*with long life!* Very low power is required, less than 1 watt on 250 volt circuit. Recommended for AC service only.

In the DIALCO assembly, the built-in current limiting (ballast) resistor (18,000 ohms) is *completely insulated in moulded bakelite* and sealed in metal (U. S. Patent No. 2,421,321) . . . Small space required—units are available for mounting in 9/16" or 11/16" clearance holes . . . A wide choice of optional features includes lens styles, shapes, and colors; terminal types; metal finishes, etc. . . . Meet applicable *MIL Spec* and *UL* and *CSA* requirements.

All Assemblies Are Available Complete with Lamp

SAMPLES ON REQUEST—AT ONCE—NO CHARGE

DIALIGHT CORP., 42 Stewart Ave., Brooklyn 37, N. Y.

Send brochures on Pilot Lights ☐ for NE-51H Neon lamp ☐ Sub-Miniatures ☐ Oil-Tight

Name ..... Position .....

Company .....

Address .....

Foremost Manufacturer of Pilot Lights

DIALIGHT CORPORATION

42 STEWART AVE., BROOKLYN 37, N. Y. • HYacinth 7-7600

For more information circle **38** on inquiry card.

MADE FOR INSTRUMENTS & CONTROLS

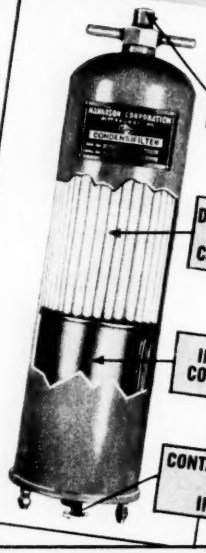
THE HANKISON Condensifilter

for "I.Q.*" Compressed Air

* the ONLY SINGLE UNIT that delivers "Instrument-Quality Air"

- MAXIMUM CONDENSATION
  Air is cooled to within 2° of cooling water
- DISPOSABLE FILTER CARTRIDGE
  Removes dirt, sludge, oil and other foreign matter
- RUGGED CONSTRUCTION
- LOW MAINTENANCE
  Needs only 1 HOUR PER YEAR servicing
- RATED CAPACITY
  100 scfm at 100 psig

Write for Bulletin M-7155



HANKISON CORPORATION
College & Pike • Canonsburg, Pa.

For more information circle **39** on inquiry card.

SPEED SENSITIVE SWITCHES

UNDERSPEED
One S.P.D.T. switch to trip at speeds as low as 400 RPM. Maximum operating speed 5,000 RPM.

OVERSPEED
One S.P.D.T. switch to trip at speeds between 500 and 6,000 RPM.

OVER and UNDERSPEED
Two S.P.D.T. switches to trip at two different speeds between 500 and 6,000 RPM.

OVER—INTERMEDIATE and UNDERSPEED
Three S.P.D.T. switches to trip at three different speeds between 1,200 and 6,000 RPM.

Speeds above or below those listed above must be referred to our Engineering Department for special consideration. Request Bulletin 504 describing our Speed Sensitive Switches.

SYNCHRO-START PRODUCTS
INCORPORATED
8151 N. RIDGEWAY AVENUE, SKOKIE, ILLINOIS
Automatic Engine Control Sets — Safety Alarm Sets — Special Control Panels — D. C. Solenoids — Heavy Duty Relays

For more information circle **40** on inquiry card.

Centralized Operations Control

In this system indications, which may be telemetering or supervisory functions, are transmitted to the central station, and control functions from the central station to the remote station may be energized at any time thereby permitting simultaneous operation in both directions.

Transmitter units generate and transmit fixed-frequency tone signals which are received by filters tuned to the identical frequencies at the other location. All signals in both directions travel along a single pair of ordinary telephone wires or other communications circuits . . . (*From new 8-page bulletin "Centralized Operations Control," Hammarlund Manufacturing Co., Inc., 460 W. 34th St., New York 1, N. Y.*)

For this literature circle **285** on inquiry card.

Electric Heating Elements

The permissible wattage rating of any given size immersion heater is determined by the viscosity of the liquid and its thermal conductivity. Consequently, immersion heaters are in general rated from 27 to 36 watts per square inch of surface for use in heating water . . . In water containing dissolved minerals that produce boiler

0 to 100						100 to 1000					
C.		F.	C.		F.	C		F	C		F
−17.8	0	32	10.0	50	122.0	38	100	212	260	500	932
−17.2	1	33.8	10.6	51	123.8	43	110	230	266	510	950
−16.7	2	35.6	11.1	52	125.6	49	120	248	271	520	968
−16.1	3	37.4	11.7	53	127.4	54	130	266	277	530	986
−15.6	4	39.2	12.2	54	129.2	60	140	284	282	540	1004
−15.0	5	41.0	12.8	55	131.0	66	150	302	288	550	1022

scale, ratings of approximately 15 to 20 watts per square inch are recommended. For oils and paraffin, wattages from 15 to 20 watts per square inch are used. However, for high viscosity liquids, ratings from 10 to 15 watts per square inch are safer; for asphalt and pitch, ratings from 5 to 10 watts per square inch are recommended. (Curves) give the heat losses from molten metal, water, oil and paraffin surfaces respectively. These curves will be found useful in determining surface losses from open vessels . . . (*From new 24-page Bulletin 74-TD, including heating formulas, heat-loss curves, and conversion tables, Trent, Inc., 201 Leverington Ave., Phila. 27, Pa.*)

For this literature circle **286** on inquiry card.

Readout Resistance Thermometer

The circuit of the Electronic Resistance Thermometer is composed of four main sections. The first is a Wheatstone bridge of unusual design, with non-linear shaping elements and suitable calibrating adjustments . . . The output of the Wheatstone bridge is fed into the second circuit section, a high gain two-stage amplifier, which has been carefully shielded, to increase the low output level of the bridge. The output of the amplifier is then fed to the third circuit section, a logarithmic converter, and from there is coupled to a phase sensitive discriminator . . . The fourth circuit section is a rectifier circuit with resistance-capacitance filters to furnish DC power to the amplifiers . . . Temperature Range: Minus 100° Centigrade to 900° Centigrade. Accuracy: 0.1° Centigrade, or 0.05%, whichever is greater. Sensitivity: 0.01° Centigrade. Readout: Digital . . . . (*From new 2-page bulletin Hoke-Manostat Corp., 148 South Dean St., Englewood, N. J.*)

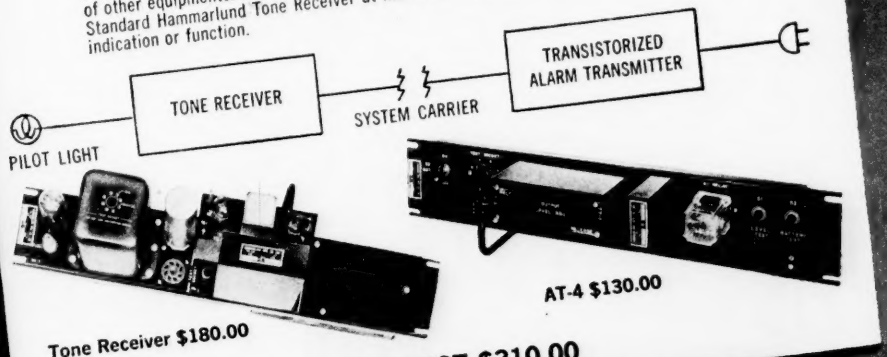
For this literature circle **287** on inquiry card.

Clean as a whistle...

THE PRACTICAL HAMMARLUND APPROACH:

POWER-OFF ALARM SYSTEM

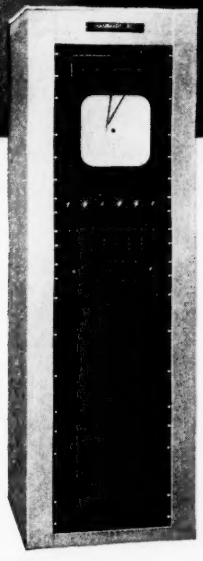
A complete Power-Off Alarm System that may be used separately or as part of a complete remote supervisory system. Self-powered AT-4 unit operates completely independently of other equipments. Senses power-off condition and transmits audio signal over carrier. Standard Hammarlund Tone Receiver at main station translates audio signal into alarm indication or function.



Tone Receiver $180.00

AT-4 $130.00

TOTAL COST $310.00



HAMMARLUND

Whether it's just a power-off alarm system, or a pyramided pulse-width selection system, Hammarlund has the practical, dependable, low-cost answer. Hammarlund offers complete systems—engineered, built and installed, of standard tone control, pulse, pulse-width equipments ready for installation in existing or new systems. If you need remote supervision, remote control, or telemetering, you need Hammarlund . . .

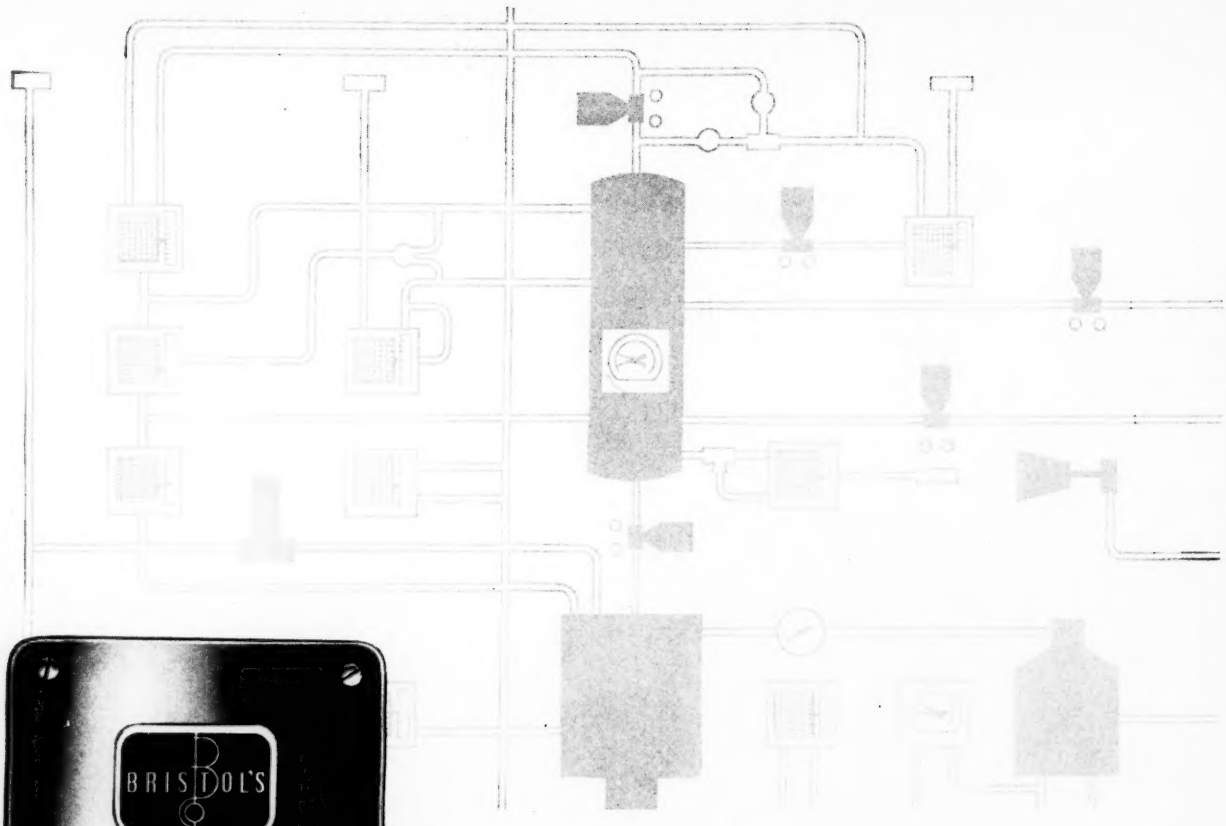
WRITE FOR COMPLETE Centralized Operations Control MANUAL . . .

Established 1910

HAMMARLUND MANUFACTURING COMPANY, INC.

460 West 34th Street, New York 1, N. Y.

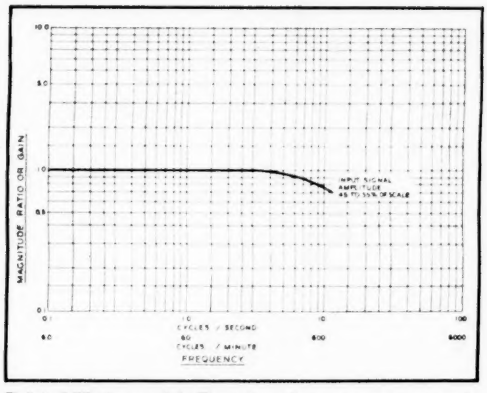
For more information circle **41** on inquiry card.



Why Bristol's Metagraphic System

gives you "Hi-Fi"

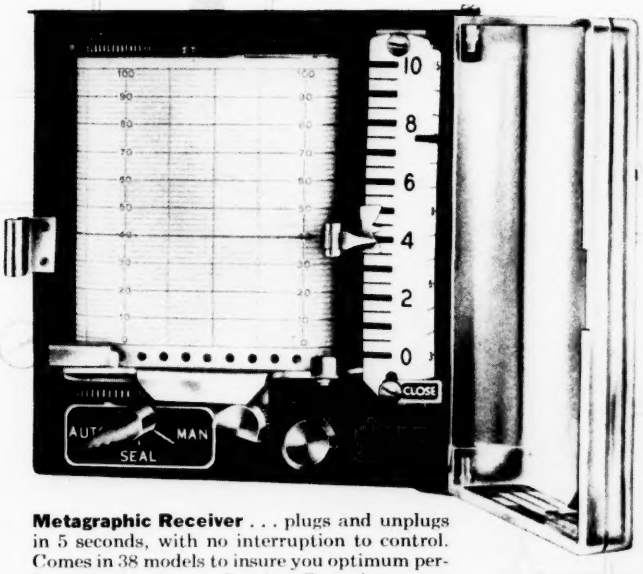
Metagraphic Transmitter ... offers you the broadest range and widest coverage for measurement of temperature, pressure, vacuum, differential pressure, flow, liquid level or mechanical motion. Standard Bristol measuring elements insure accuracy. 3-15 psi output signal.



Bristol Metagraphic Receiver frequency response is outstanding for a pneumatic instrument. At high end, the 70.7% response point occurs well above 10 cycles per second.

See our exhibits in Booths 20-21 at the National Telemetering Show and Booths 528-530 at the Automation Show.

For more information on Transmitters circle **42**: Receivers **43**: Controllers **44**.



Metagraphic Receiver . . . plugs and unplugs in 5 seconds, with no interruption to control. Comes in 38 models to insure you optimum performance in your application. Set point, measured variable and valve position are continuously indicated on same scale. Indicator models also available.

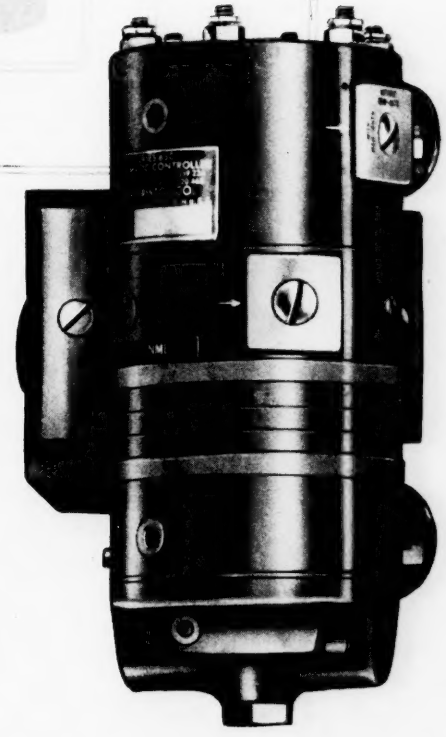
pneumatic control

Many of the instrument men using the Bristol Metagraphic pneumatic system are hi-fi hobbyists. The term "hi-fi" just naturally comes to mind when they compare the performance of the Bristol Metagraphic with other makes of pneumatic control systems.

The Metagraphic Receiver has, without question, the best frequency response characteristic of any comparable pneumatic receiver on the market. In fact, it's being used as a test standard by one user for response analysis.

And, the matched characteristics of the Metagraphic transmitter and controller insure you optimum process control . . . with minimum lag or other distortion.

If your process needs the best in pneumatic control systems, get complete data on the Bristol Metagraphic. Our engineers will be glad to discuss, in detail, the characteristics of the Metagraphic system and how the system can be adapted to your particular requirements. The Bristol Company, 113 Bristol Road, Waterbury 20, Conn. B.5



Metagraphic Controller . . . this outstandingly rugged, trouble-free controller supplies precision pneumatic control of almost any variable. Operates from "universal" 3-15 psi pneumatic input signal. Proved force-balance operating principle requires almost no moving parts, nothing to wear out.

BRISTOL ***TRAIL-BLAZERS IN PROCESS INSTRUMENTATION***

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more information on Transmitters circle **42**: Receivers **43**: Controllers **44**.

this
G-V time delay relay
does many jobs

other thermal relays cannot do...

- For military or industrial use
- Miniature and octal sizes
- Plug-in or flanged mounting
- Hermetically sealed
- Adjustable or non-adjustable
- Delay intervals 1/4 sec. to 5 minutes
- Unaffected by ambient temperatures -70° to 100°C

Our facilities assure prompt deliveries

Write for bulletin and help with your particular problems

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60 Hollywood Plaza
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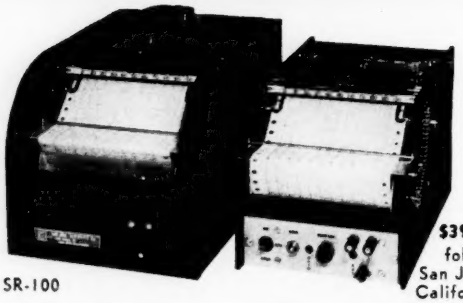
STABLE . . . RELIABLE . . .
ACCURATE . . . PORTABLE



SR-100

$395 fob San Jose, California

NEW! STRIP CHART RECORDER

A null-balance potentiometer recorder with full scale span at 10 millivolts up to 100.

Design facilitates easy application with any type transducer. These features also available in SR-100 2C dual channel instrument. High-low limits and time event marking available on both models.

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ELECTRONIC DESIGN ENGINEERS AND MANUFACTURERS
605 SUNOL STREET SAN JOSE, CALIFORNIA

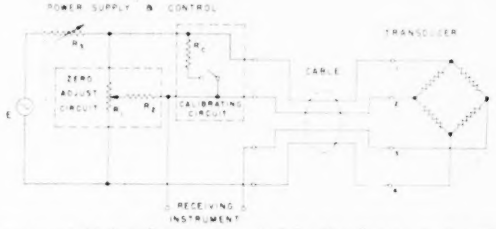
For more information circle **46** on inquiry card.

BRIEFS—CONTINUED

Pressure Transducer Element

The Statham unbonded strain gage is an electromechanical device which transduces minute displacements to proportional resistance changes. The transducer is electrically and mechanically symmetrical. In the center of a stationary frame, an armature is supported rigidly in the plane perpendicular to the longitudinal axis. Wound

Fig 8



between rigid insulators mounted in the frame and armature are four filaments of strain-sensitive resistance wire. The filaments are of equal length . . . As the armature is caused to move longitudinally to the left by an external force, Elements A and D increase in length while Elements B and C decrease in length . . . The change in resistance of the filaments is proportional to their change in length. The resistance change of the filaments alters the electrical balance of a (Wheatstone) bridge to produce an electric signal in the output circuit . . . (*From new 20-page Loose-leaf binder [green] Statham Laboratories, 12401 W. Olympic Blvd., Los Angeles 64, Calif.*)

For this literature circle **288** on inquiry card.

M-S-A Gas Thermatron

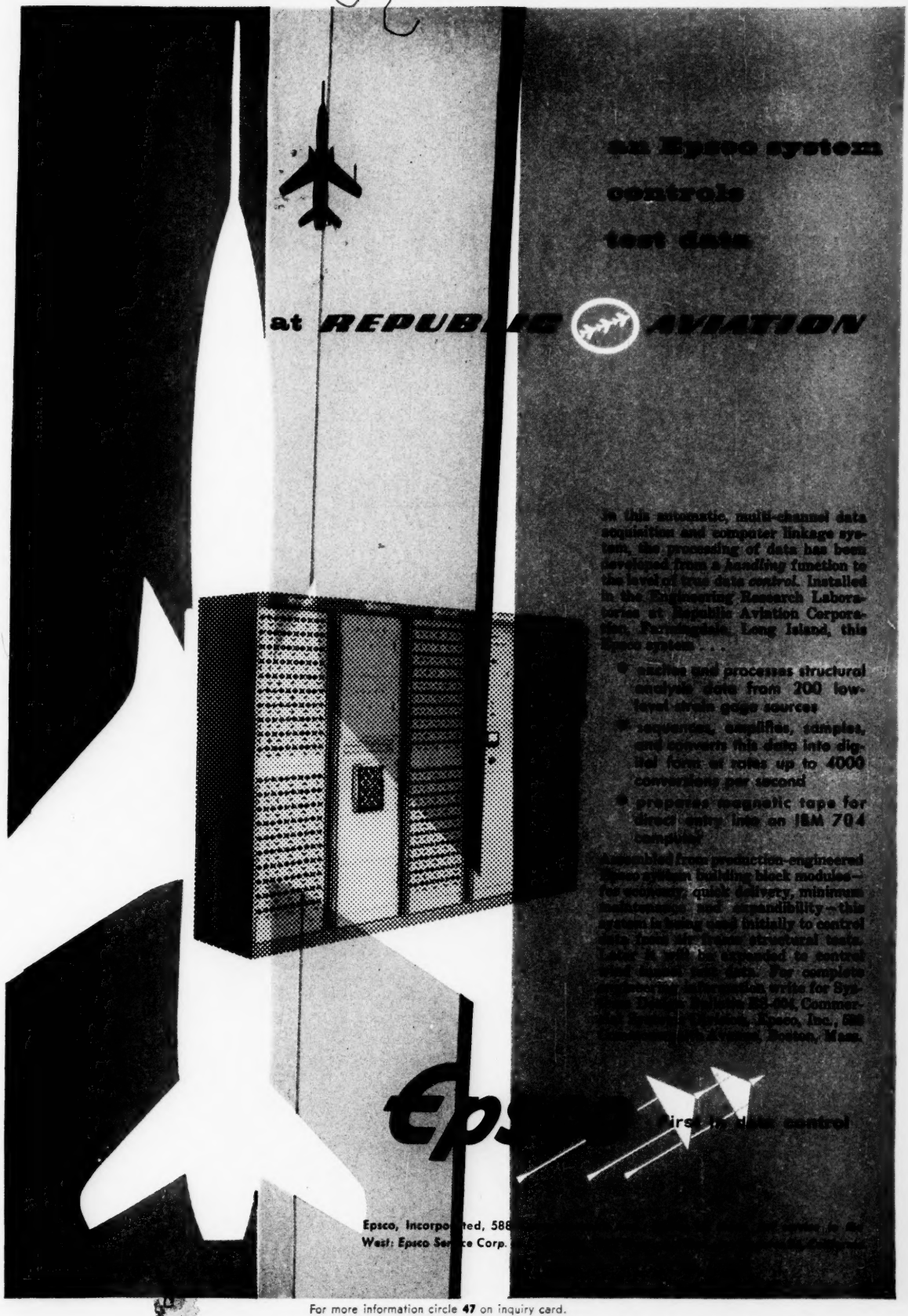
Conventional analyzers using the thermal conductivity principle rely on the fact that rate of heat loss from a heated filament in a chamber is proportional to the thermal conductivity coefficient of the gas contained . . . . In the M-S-A Gas Thermatron the thermal convection of the gas mixture is used as well as the thermal conductivity effects which occur in the cell to provide an accurate analysis of one component in a multicomponent gas mixture . . . The difference between the rate of heat loss in a large cell and that in a small cell becomes greater as the thermal conductivity of the gas decreases. This effect is usually referred to as gaseous "convection" in thermal conductivity cells . . . The gas to be analyzed is passed through one large and one small cell and the reference gas is either sealed or flowed through the other pair of cells. The filaments are arranged in a Wheatstone bridge circuit . . . The principle used to make the bridge insensitive to the thermal effects of interfering gases consists of adding equal resistances to the circuits of those cells where the effects are at a maximum, while keeping the bridge current constant . . . (*From new 4-page Bulletin No. 0716-1, Mine Safety Appliances Co., 201 N. Braddock Ave., Pittsburgh 8, Pa.*)

For this literature circle **289** on inquiry card.

Numerical Positioning Control

The major units of numerical positioning control are the data input, director, and servo drive. With four basic types of data input available, the choice will depend largely on the requirements of the machine and the degree of automation which the user wishes to place in the machine . . . On repetitive operations where it is possible to pre-plan the program, punched cards or punched tape will make the operation fully automatic. (*From new 14-page Bulletin GET-2676, General Electric Company, Specialty Control Dept., Waynesboro, Va.*)

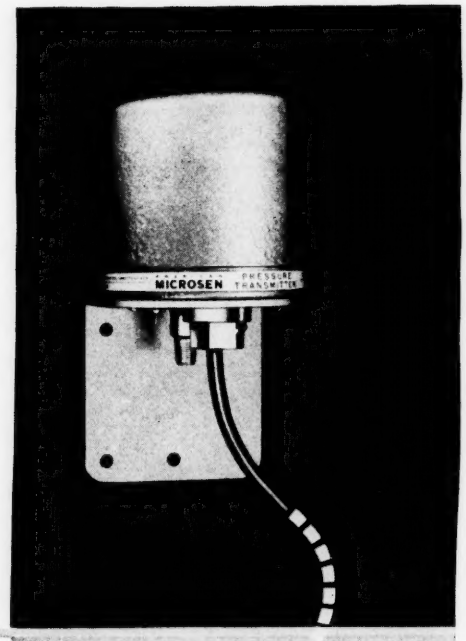
For this literature circle **290** on inquiry card.

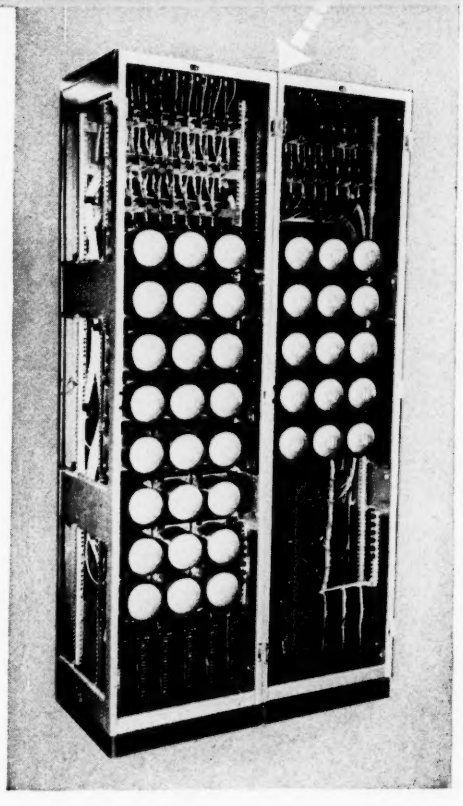

an Epsco system
controls
test data
at REPUBLIC AVIATION
In this automatic, multi-channel data acquisition and computer linkage system, the processing of data has been developed from a handling function to the level of true data control. Installed in the Engineering Research Laboratories at Republic Aviation Corporation, Farmingdale, Long Island, this Epsco system . . .
• reads and processes structural analysis data from 200 low-level strain gage sources
• sequences, amplifies, samples, and converts this data into digital form at rates up to 4000 conversions per second
• prepares magnetic tape for direct entry into an IBM 704 computer
Assembled from production-engineered Epsco system building block modules—for economy, quick delivery, minimum maintenance, and expandibility—this system is being used initially to control static load tests on structural tests. . . . will be expanded to control . . . data. For complete . . . information, write for Sys. . . . Bulletin SS-400, Commer. . . . Epsco, Inc., 588 . . . Boston, Mass.
Epsco
. . . control
Epsco, Incorporated, 588 . . .
West: Epsco Service Corp. . . .

For more information circle **47** on inquiry card.

NOW... a compact ELECTRO-PNEUMATIC PRESSURE TRANSDUCER

for data reduction systems





The American-Microsen® Series 185 Pressure Transducer is designed to convert pressure signals to dc signals for use with data handling, telemetering or computer equipment. It can be supplied with input ranges from 0-15 psi up to 0-1000 psi; also 3-15 psi to transduce pneumatic signals.

The Series 185 Pressure Transducer converts pressure signals to 1.0 to 5.0 ma. dc which is readily accepted by data handling systems. Sensitivity of the unit is practically infinite. It has a repeatability of 0.3% of span; speed of response is 10 cps.

Use of the Microsen Balance enables the transducer to transmit signals instantaneously over long distances. An external power supply is employed which can be filtered to provide a high signal-to-noise ratio as required in high speed data handling equipment.

Housed in a dust and weatherproof case for universal mounting, the Series 185 Pressure Transducer can be installed on a vertical surface, pipe pedestal or meter piping. It is also readily adaptable to rack mounting as shown at the right. Get detailed information. *Write for Bulletin TP515.*

MANNING, MAXWELL & MOORE, INC.

INDUSTRIAL CONTROLS DIVISION · DANBURY, CONNECTICUT

MAKERS OF 'AMERICAN-MICROSEN' ELECTRONIC INSTRUMENTS FOR MEASUREMENT, TRANSMISSION AND CONTROL

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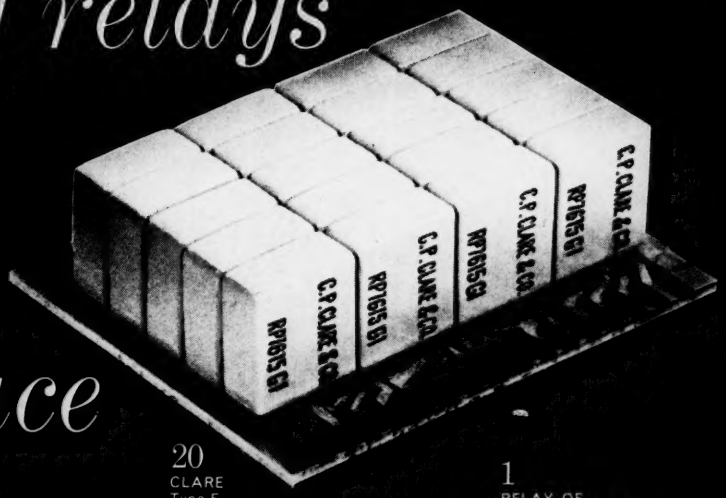
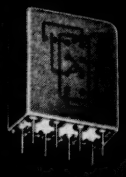
Circle **49** on inquiry card. ⟶

20 times as many relays in 1/3 the space



20
CLARE
Type F
RELAYS
10½ cu. in.

1
RELAY OF
EARLIER DESIGN
31¼ cu. in.



CLARE *Type* F RELAY

SPECIFICATIONS:

Ambient Temperature	—65° C to +125° C.
Shock	50 Gs for 11 milliseconds.
Vibration	5-75 cps at maximum excursion of ⅛-inch, 75-2000 cps at 20 Gs acceleration.
Dielectric Strength	Sea level—1000 volts rms between terminals and frame, and between adjacent circuits; 750 volts rms between contacts of a set. At 80,000 ft., 350 volts rms.
Insulation Resistance	1000 megohms minimum at 125° C.
Coils	Coils up to 10,000 ohms available for a wide range of voltages or currents.
Nominal Operating Power	250 milliwatts.
Pickup Time	3.5 milliseconds nominal.
Dropout Time	1.5 milliseconds nominal.
Contact Arrangement	2 pdt (2 form C).
Contact Rating	3 amps resistive at 28 volts d-c or 115 volts a-c; also for low-level applications.
Contact Resistance	0.050 ohm maximum.
Contact Life	500,000 operations minimum at 2 amps; 100,000 operations minimum at 3 amps.
Enclosure	Hermetically sealed, filled with dry nitrogen at 1 atmosphere pressure.
Mounting	All popular mounting arrangements available.
Terminals	Printed circuit; solder; plug-in (matching socket available). Variations of printed-circuit terminal length on 1/10-inch grid spacing available.
Weight	17 grams.
Military Specifications	MIL-R-25018; MIL-R-5757C, except as to contact overload.

These twenty Clare Type F Modular Relays, mounted on a printed-circuit board, take less than a third of the space occupied by a hermetically sealed relay of earlier design—a relay in wide use a few short years ago.

Clare Type F Modular Relays can be mounted in a closely restricted space—wherever the user desires—on a board punched at 2/10 inch intervals in a grid pattern.

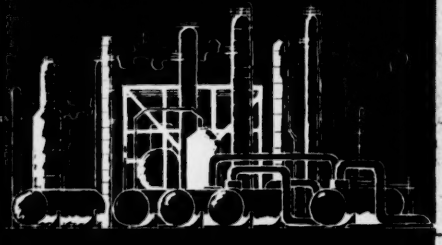
This new hermetically sealed relay—no bigger than a postage stamp—is fast and more than moderately sensitive, yet stalwart enough to withstand extremes of temperature, heavy shock, and severe vibration.

Send for Bulletin 124 today. Write: C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: C. P. Clare Canada Ltd., 2700 Jane Street, Toronto 15. Cable Address: CLARELAY.

CLARE RELAYS

FIRST in the industrial field

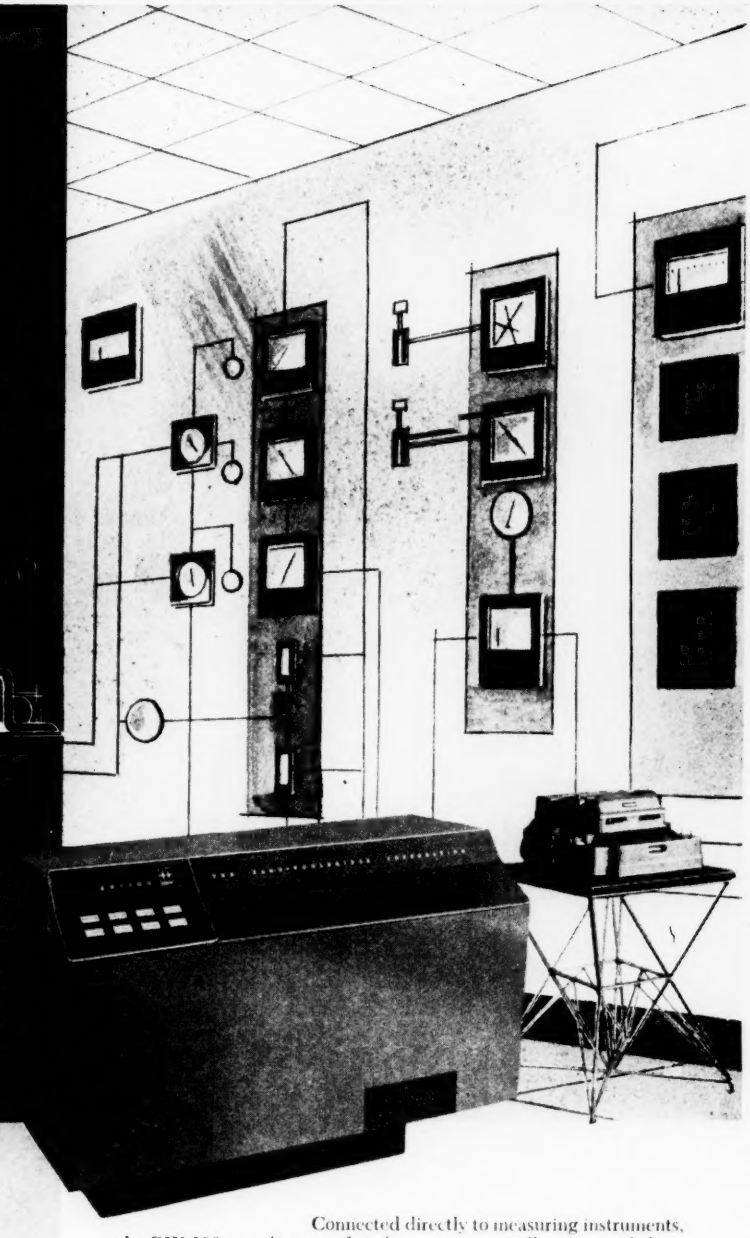
advanced data logging



...with the

RW-300

digital control computer



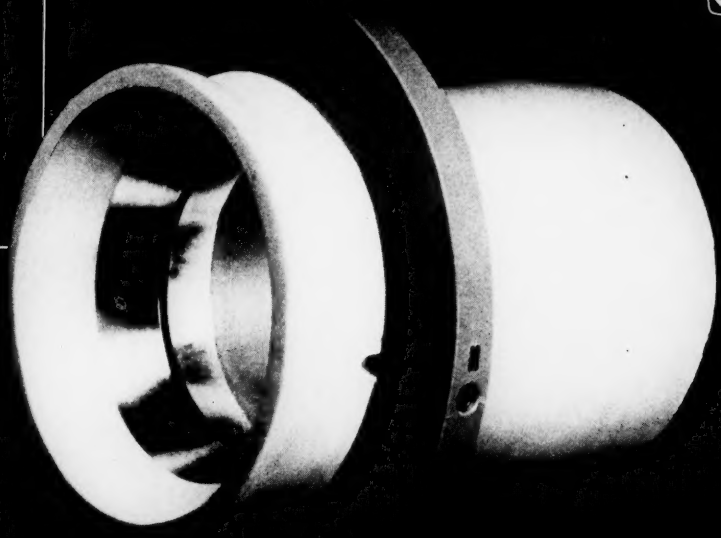
The Ramo-Wooldridge RW-300 Digital Control Computer—the first digital computer designed specifically for automatic on-line process control and data logging—offers significant advantages as the heart of advanced data logging and scanning systems for oil refining, chemical, and other process industries. Unlike conventional data loggers, the RW-300 can be converted to completely automatic control through a minor field modification without purchasing expensive additional equipment and without scrapping any part of the existing logger.

Connected directly to measuring instruments, the RW-300 can do more than log raw or partially processed data. It can also compute and immediately print out more meaningful information such as yields, conversion efficiencies, and energy balances. The RW-300 can also calculate operating guides for plant personnel to follow. In addition to checking process variables against upper and lower limits, the RW-300 can perform more sophisticated checks on process equipment and the process itself. These checks reduce plant maintenance costs by detecting faulty operation of the process in time for corrective action.

For technical information on automatic process control and advanced data logging with the RW-300, write: Director of Marketing, The Thompson-Ramo-Wooldridge Products Company, P. O. Box 45067, Airport Station, Los Angeles 45, California, or call OSborne 5-4601.

THE THOMPSON-RAMO-WOOLDRIDGE PRODUCTS COMPANY

For more information circle **50** on inquiry card.

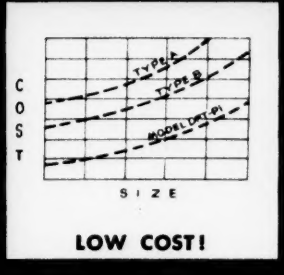


NEW!

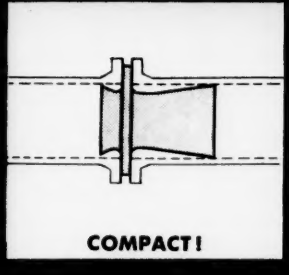
LOW COST

CORROSION-RESISTANT

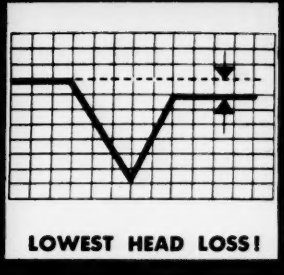
FLOW TUBE!



LOW COST!



COMPACT!



LOWEST HEAD LOSS!

LIGHTWEIGHT!

RUGGED PLASTIC INSERT DALL FLOW TUBE METERS ACIDS, ALKALIES, SLURRIES, GASES!

NAME: Builders-Providence Model DFT-PI.

MATERIAL: Made of epoxy or polyester resins reinforced with fiberglas . . . . with corrosion-resistant metallic throat-ring and flange.

INSERT DESIGN: Installs between pipe flanges on process line; no field drilling required; cuts head loss 90%!

ACCURACY: Uncalibrated — within ±1% of actual flow rate; calibrated — within ±½ of 1%. Combined enduring accuracy with absolute minimum head loss.

PERFORMANCE GUARANTEED: Backed by Builders' 65 years of active design and manufacturing experience in the flow meter field.

POSITIVE CONTROL OF MATERIALS IN MOTION

BUILDERS-PROVIDENCE
DIVISION OF
B-I-F INDUSTRIES
METERS FEEDERS CONTROLS

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BUILDERS-PROVIDENCE, INC., 422 Harris Ave., Prov. 1, R. I.

☐ Please rush me complete data on this amazing new Plastic-Insert type of Dall Flow Tube.

Name ..... *Title* .....

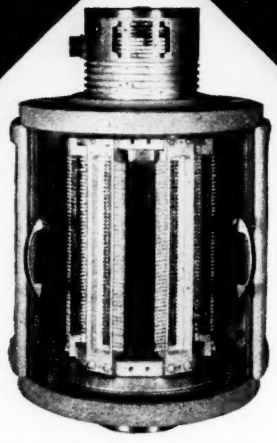
Company .....

Street .....

City ..... *Zone* ..... *State* .....

Now you can order from stock...
the new
BRYANT MAGNETIC STORAGE DRUM

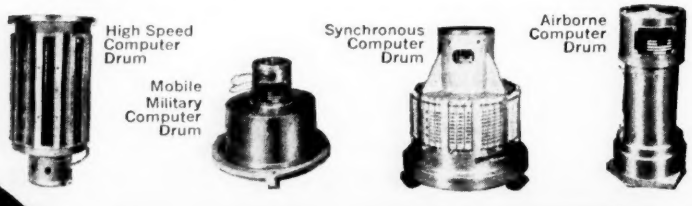
Unequalled for precision, versatility, and low cost



The new 512A Bryant general purpose magnetic storage drum meets the exacting demands of all permanent storage problems, yet is versatile enough to be used as a laboratory instrument. These 5" dia. x 12" long drums are stocked for immediate shipment at a price that is far below the cost of customer-designed drums.

Features: Guaranteed accuracy of drum run-out, .00010" T.I.R. or less; Integral motor drive; Capacities to 625,000 bits; Speeds up to 12,000 R.P.M.; 500 kilocycle drum operation possible; Accommodates up to 240 magnetic read/record heads; For re-circulating registers as well as general storage.

Special Models: If your storage requirements cannot be handled by standard units, Bryant will assist you in the design and manufacture of custom-made drums. Speeds from 60 to 120,000 R.P.M. can be attained, with frequencies from 20 C.P.S. to 5 M.C. Sizes can range from 2" to 20" diameter, with storage up to 6,000,000 bits. Units include Bryant-built integral motors with ball or air bearings. Write for Model 512A booklet, or for special information.



BRYANT GAGE and SPINDLE DIVISION
P. O. Box 620-I, Springfield, Vermont, U. S. A.
DIVISION OF BRYANT CHUCKING GRINDER CO.

For more information circle **52** on inquiry card.

Panhandle Pete

Since the circuit is the heart of all electronics, here then are three more entangled and uninteresting hearts er. circuits, from the Research Laboratories of Wallace Electronic Service Co., released through the courtesy of Dr. O. U. Alles. The Low-Power Transmitter is currently being used in the Un-Guided Missile Program: the R. F. Amplifier is part of the five-and-a-half stage amplification used in the Model F.H. 4 Raket. The new patented vacuum tube is so strange that there is a committee studying the tube and they will come to a conclusion you may be sure.

New Vacuum Tube—Fig. 1

This patent covers the invention of a new type vacuum tube which may act as a generator of high-frequency oscillations and, by a special arrangement, modulate the high frequency oscillations by means of the variations of microphonic currents impressed upon a separate grid.

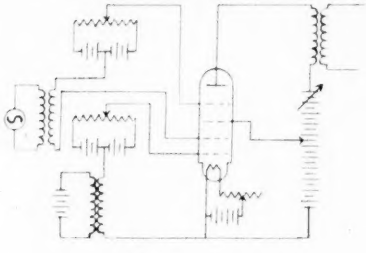


FIG. 1

The design of this tube is shown in Fig. 1. The tube is separated into two sections by a cathode which is composed of a thin piece of tungsten or platinum. This cathode seals the chamber in half. When electrons are emitted by the filament, the cathode is bombarded and becomes an electron-emitting body ($I_s = AT^2_e{}^{-b/T}$). The grid in the lower half may be held at any desired potential with respect to the filament: the cathode is held at some potential which is positive with respect to the filament and the grid in the upper half of the tube and the plate can be held at any potential with respect to the cathode.

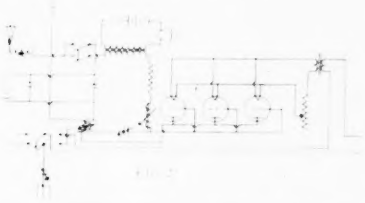
High-frequency oscillations impressed upon the primary of the

Long Leads And Short Circuits

transformer are repeated, of course, (?) in the plate circuit and connecting to the transformer in the radiating antenna. The modulating current is impressed upon grid G which introduces corresponding variations in the amplitude of the high frequency oscillations.

Low-Power Transmitter—Fig. 2

A glance at Fig. 2 shows the circuit employed is well-known and reveals that the modulation is brought about by direct grid control. Since this method has been practically abandoned by many experimenters in favor of the valve system of modulation, it is, therefore, of interest to know that Dr. Alles has demonstrated that for low-power, this simple, inexpensive, fool-proof means of producing V.C. is equally efficient, if not more so, than the elaborate and expensive valve system.



The transmitting valves are 5-watt power tubes, the filaments of which are run at 6 volts instead of 7.5 volts, for long life. (Lets run them at 1.5 volts and make them last forever? —MHA). The plate current for exciting the tubes is drawn from the M.G. set, developing 300 volts and passing 30 mils, giving a maximum input of 9 watts. (Ho hum. Wonder how the Pirates are doing to-day? —MHA).

The aerial and earthing system deserve special mention. The aerial has been specially designed and consists of 4-1/18th gauge copper wire equally spaced around wooden hoops 2'6" in diameter. The center is fixed to an 80 foot mast. The earth system consists of a connection to a water pipe together with a balanced counterpoise. The aerial-counterpoise is very carefully tuned to the same as the aerial. With the inclusion of the counterpoise the radiation is increased by 33% giving a total radiation of 1 to 1.2 amperes.

R.F. Amplifier—Fig. 3

This invention introduces a new method of amplifying r.-f. currents. The results are attained by resistance retro-actions between the plate of one tube and the grid of a second tube and between the plate of the second tube and the grid of the first tube (so you push the first valve down and the current goes down - - MHA).

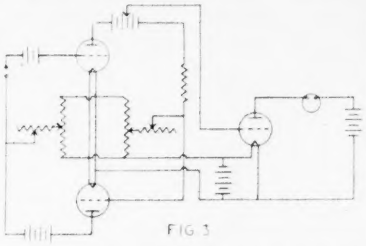


FIG. 3

A rise in the potential in the grid of the first tube produces a rise in current on the plate of the tube which affects a fall of potential of the grid on the second tube and fall in current to its plate with a consequent rise of potential of the grid of the first tube. (Anybody want to go swimming? - - MHA). Thus any change of potential of the grid or the plate may be made to sustain itself.

The principle may be put to use in various ways and may be applied to obtain amplification, rectification, control of electric circuits by variations of their resistances and generation of sustained oscillations, in any manner in which other negative resistance devices may be used for these purposes. The invention in this form may be used as a current-limiting amplifier for wireless signals to aid in cutting out interference from atmospherics or other signals. This function is invaluable in un-guided missile theory. (Let's be honest; where did you get all this dope? - - MHA) (In case you are real interested, you can find all this information in the December 1922 issue of *Radio News* from which it is re-printed through the courtesy of *Radio & Television News*. - - P.P.)

Panhandle Pete

icy stare at 15,000 feet

reports the effects of cold on the wing-surfaces of high-flying aircraft through the eye of GPL closed-circuit television.

How many jobs could GPL Industrial TV help you do better?

You'll never know until you investigate! You'll be amazed at the versatility, simple operation, and low cost of Industrial TV systems by GPL, one of the world's leading manufacturers of industrial, military and broadcast TV.

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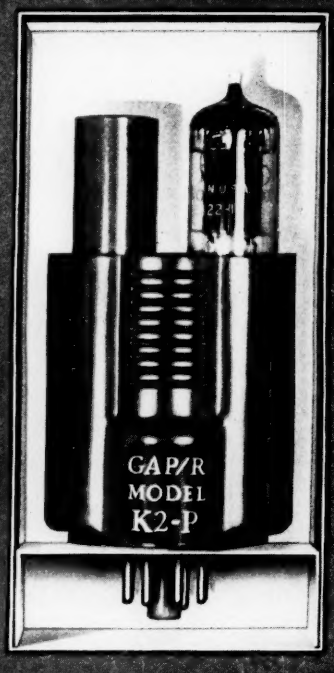
PLEASANTVILLE, NEW YORK

For more information circle **53** on inquiry card.

PLUG FOR ANALOG

FAST DC AMPLIFIER: Model K2-W is an efficient and foolproof high-gain operational unit for all feedback computations, fast and slow. A number of special varieties are also in quantity production. **($24.00)**



SLOW DC AMPLIFIER: Model K2-P offers long-term sub-millivolt stability, either by itself or in tandem with the K2-W. High-impedance chopper-modulated input. Filtered output to drive balancing grid or follower. **($60.00)**

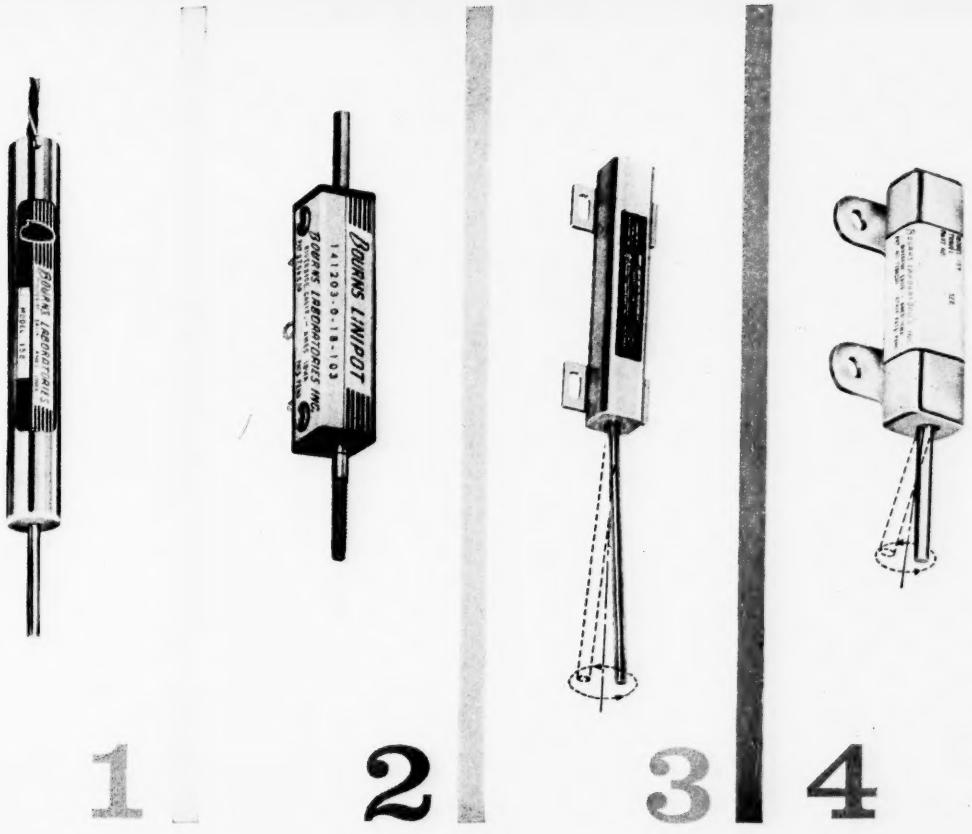
SERRASSOID GENERATOR: Model K2-G produces a fixed triangular wave of 100 V peak-peak, at 500 kcps. Use it for quadratic rounding in diode networks, and for many other non-linear recreations. **($29.00)**

PHILBRICK uses these octal plug-in modules, and many others like them in their standard computing instruments. They are tried and true, compact, convenient, and economical. You too can find profit and happiness with their help . . . . . *All K2 Plug-ins run on plus and minus 300 VDC and 6.3 VAC. Socket wiring is simple and standardized. Write for freely given opinions on your application.*

The analog way is the model way . . . . . GEORGE A. **PHILBRICK** RESEARCHES, INC.

228 Congress St., Boston 10, Massachusetts

For more information circle **54** on inquiry card.



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Here are four problem-solvers made especially for travels of ½" to 6".
These are *small* instruments—units you can fit into the really *tight* spaces.
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...and each one solves a *special problem, too:*

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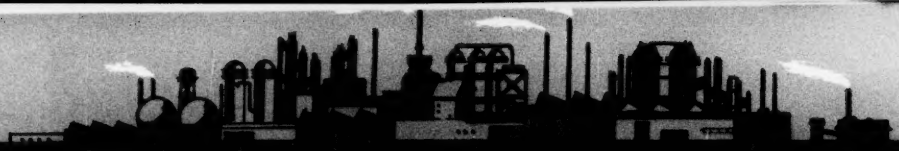
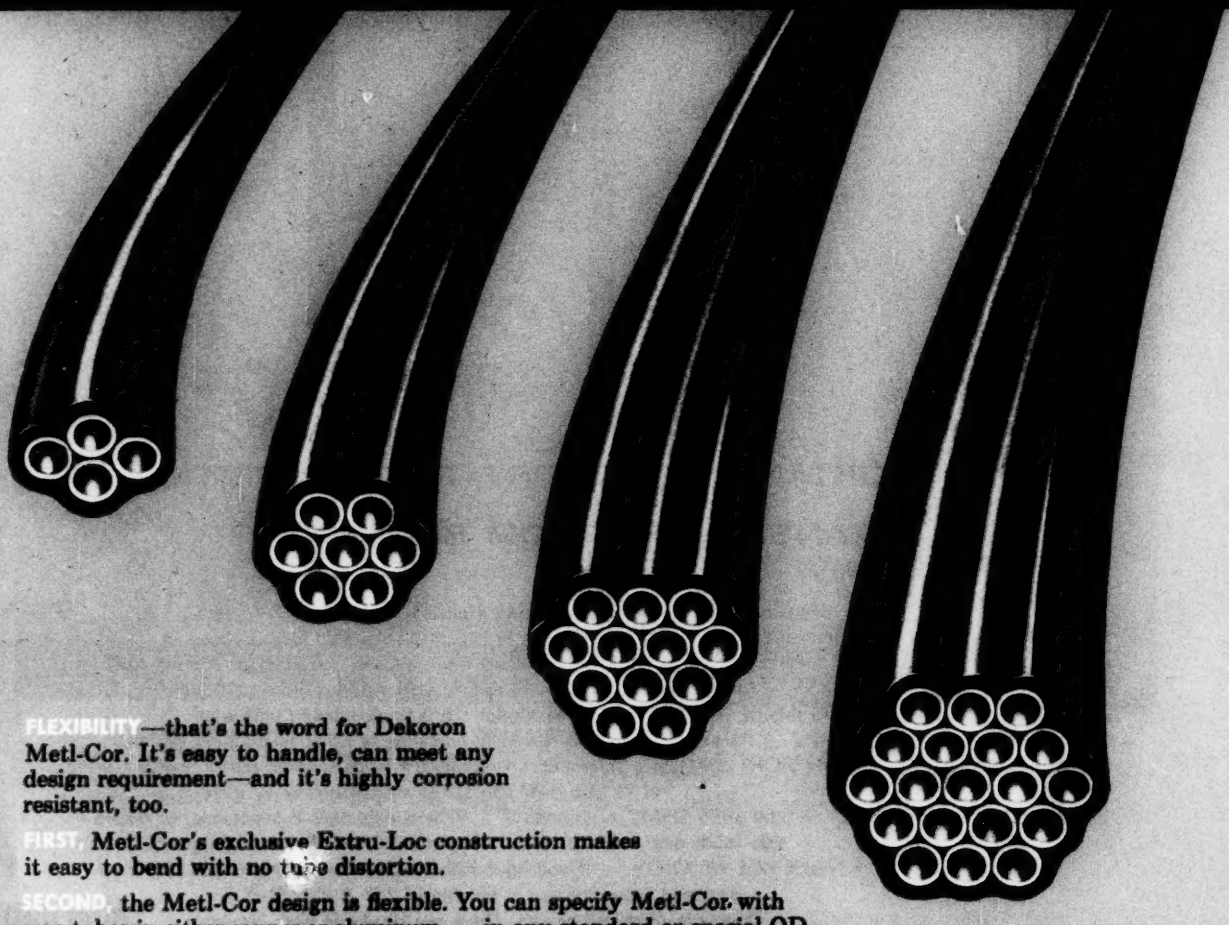


DEKORON METL-COR MULTIPLE TUBE HARNESS

cuts installation costs

bends without distortion

solves instrument line corrosion problems



FLEXIBILITY—that's the word for Dekoron Metl-Cor. It's easy to handle, can meet any design requirement—and it's highly corrosion resistant, too.

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DEKORON PRODUCTS DIVISION • MANTUA, OHIO

For more information circle 86 on inquiry card.

BIOGRAPHIES

of Significance

"Al" Adler, chief instrumentation engineer of one of the largest contracting firms in the country, rose from the ranks to reach his important position. This month we are pleased to acknowledge the contributions to our field that have been made by Mr. Adler, and to show how a background of field instrumentation, supervision of construction installation and maintenance, general trouble shooting, and training and supervision of instrument department personnel, provide a background for today's top positions in the instrument industry.

E. Albert Adler

A native of Philadelphia, Al went to high school in the city and attended science and engineering courses at the University of Pennsylvania and Drexel Institute, after having spent a year at Penn State University.

He began his career in instrumentation when in 1934 he joined the instrument department at Gulf Oil's refinery in Philadelphia. He later became assistant department foreman. Working with refining units and supporting facilities such as water treating and power plants, he supervised construction and installation, did service and maintenance work, organized instrument records, and prepared specifications for purchase of instruments.

He switched to Sun Oil's Marcus Hook refinery in 1940 where he served as Senior Instrument Engineer until he joined United Engineers & Constructors in 1947.

At Sun Oil Company, new construction of plants utilizing many advances in petroleum processing technology provided the opportunity to further his fund of first-hand knowledge. Al's task was specific supervision of all crafts during construction and maintenance operations involving instrumentation; collaboration with process and development engineers to develop methods incident to new processes; general trouble shooting of existing installations; supervision of junior engineers; training and instruction of Instrument Department personnel; preparation of specifications; and design of instrument applications.

Today E. Albert Adler is Chief Instrumentation Engineer of United Engineers & Constructors Inc., Philadelphia, supervising the instrumentation department of one of the leading contracting firms in the United States. His company plans, constructs, and puts in operation entire plants, or enlarges existing facilities. The instrumentation projects for which he has contributed significantly include many chemical manufacturing plants, steel companies, and power and light generating facilities.

Al is a licensed professional engineer in Pennsylvania and author of several technical papers.

A charter member of the Philadelphia Section of ISA, he served as treasurer, vice-president, and president in successive years from 1951 through 1953. He was on various local committees, including the symposia the Section arranges every year, and was Symposium technical chairman in 1956 and 1957. After serving on various committees of the national organization he was elected as district vice president of the ISA for 1957 and 1958.

Al is a civic minded man. Besides passing on his knowledge in instrumentation as instructor and administrator of courses which the Philadelphia Section of the ISA sponsored and Pennsylvania State University administered in 1945-1947, he has been active in the church council, the boy scouts, the PTA, Civic Association, and Civil Defense. Al is married, has three sons and lives in suburban Springfield. He tells us that he has been reading *I&A* for 12 years.

Al will serve as chairman of the technical session on Automatic Control Valves at the forthcoming Fourth International Automation Exposition and Congress (New York, June 9-13, 1958).

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Sie sind herzlich eingeladen, den 4. internationalen Automation-Kongress und die damit verbundene Ausstellung vom 9. bis 13. Juni 1958 in New York zu besuchen.

Vous êtes cordialement invité à visiter la Quatrième Exposition Internationale de l'Automation et à participer au Congrès qui auront lieu à New York, du 9 au 13 Juin 1958.

Wij hebben het genoegen U uit te nodigen tot een bezoek aan het Vierde Internationale Automatie Congres en aan de tentoonstelling in New York, van 9 tot 13 juni, 1958.

Temos o prazer de convidar V. Exa. a visitar o Quarto Congresso e Exposição Internacional de Automatização, em Nova York, de 9 a 13 de Junho, 1958.

Invitamos a usted cordialmente a visitar el IV Congreso y Exposición Internacional sobre Automatismo que tendrá lugar en Nueva York los días 9 a 13 de Junio de 1958 .

La S.V. è cordialmente invitata a visita la Quarta Esposizione Internazionale di Automazione che avrà luogo in New York dal 9 al 13 giugno 1958.

Ni är hjärtligt välkommen att besöka den Fjärde Internationella Kongressen och Utställningen om Automation i New York den 9-13 juni 1958.

Pyydämme ystävällisesti Teitä tutustumaan Neljänteen Kansainväliseen Automatisointikongressiin ja sen yhteydessä järjestettävään näyttelyyn New Yorkissa 9.6.-13.6.1958.

De indbydes venligst til at besøge den fjerde internationale Automation Kongres og Udstilling i New York den 9-13 juni 1958.

Σᾶς προσκαλοῦμεν ἐγκαρδίως ὅπως ἐπισκεφθῆτε τό 4ον Διεθνές Συνέδριον καί τήν Ἔκθεσιν Αὐτοματισμοῦ τῆς Νέας Ὑόρκης τῆς 9 - 13 Ἰουνίου 1958 .

9-13 Haziran 1958 tarihlerinde New York'ta toplanacak olan Milletlerarası 4'ncü Otomasyon Kongre ve Sergisini ziyarete teşrifiniz rica olunur.

Srdečně Vás zveme na čtvrtý mezinárodní kongres a výstavu automatisace v Novém Yorku, 9.-13. června 1958.

Uprzejmie zapraszamy na IV Międzynarodowy kongres i Wystawę Automatyzacji w Nowym Jorku w dniach od 9 do 13 czerwca, 1958 r.

TISZTELETTEL MEGHIVJUK ÖNT, HOGY LÁTOGASSON EL AZ 1958 JUNIUS 9 ÉS 13 KÖZÖTT, NEW YORKBAN RENDEZENDŐ NEGYEDIK NEMZETKÖZI AUTOMATIZÁLÁSI KONGRESSZUSRA ÉS KIÁLLITÁSRA:

Srdačno se pozivate da posetite Četvrti Medjunarodni kongres i izložbu automatizacije koji će se održati u New York-u od 9-13 juna 1958 godine.

Sunteţi călduros invitaţi să vizitaţi cel de al IV-lea Congres Internaţional de automaţie şi Expozitia ce va avea loc in New York între 9-13 iunie,1958

הננו מתכבדים להזמינך בזה לקונגרס הבינלאומי הרביעי ולתערוכת מיכון אבטומטי אשר יערכו בניו יורק בין 9 - 13 ביוני 1958."

Вы любезно приглашаетесь посетить 4-й Международный Конгресс и выотавку по автоматике, которые состоятся в г.Нью-Йорке с 9 по I3 июня I958 года .

आपसे सानुरोध प्रार्थना है कि न्यू यॉर्क मे, ९ से 13 जून तक होने वाले, स्वयं-चालक यन्त्रों के चतुर्थ अन्तर्राष्ट्रीय प्रदर्शन को देखने के लिए अवश्य पधारें।

TRANSLATION

"You are cordially invited to visit the Fourth International Automation Congress and Exposition, New York, June 9-13, 1958."

For information write
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845 Ridge Ave., Pgh. 12, Pa.

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Basic system consists of signal transmitter, magnetic servo amplifier, null-balance indicator. (No electron tubes, slide-wires or continuously moving parts.)

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Non-pulsating pressure.
Original performance constant over a long pump life.
Low maintenance cost.

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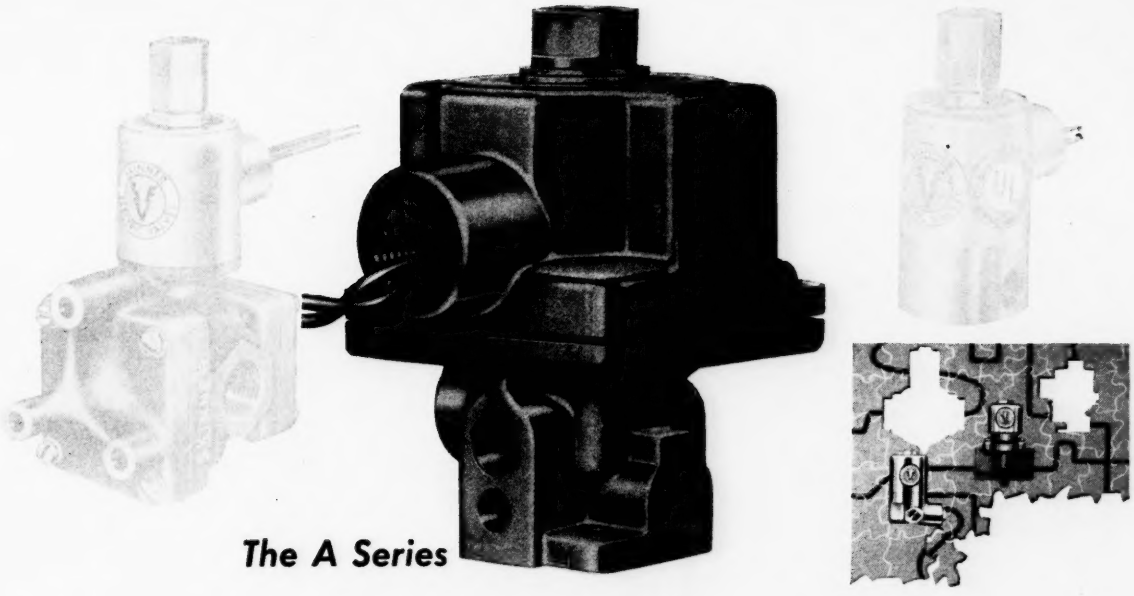


The A Series

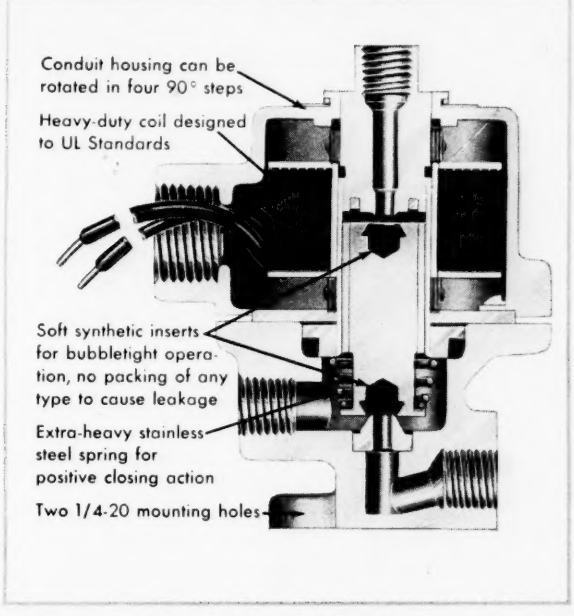
NEW— three-way Skinner Valve line for medium-size cylinders

This new A Series valve line bridges the gap between the famous V5 line used with small cylinders and the reliable M3 line used with large cylinders. The design of this new line permits economical and efficient operation of medium-size cylinders as well as faster operation of smaller cylinders where increased cycling speed is a necessity.

The first of the A Series line is a 3-way normally closed valve with a $\frac{5}{32}$" orifice and $\frac{1}{4}$" NPT ports, and a pressure rating of 125 PSI. It is designed for use with such media as oil, air and inert gases.

Despite the increase in capacity, this new valve is light in weight (only 3 pounds) and compact ($3\frac{7}{8}$" high and $2\frac{5}{8}$" square). The body and mounting are non-corrosive zinc and the internal parts are stainless steel. The plunger is spring-loaded and direct-acting, and the valve can be mounted in any position. Soft synthetic inserts are used, assuring bubbletight operation and long, trouble-free life.

For additional information, options and specifications, call the Skinner Representative or Distributor nearest you – he's listed in the Yellow Pages. Or write us at the address below, Dept. 415.


Conduit housing can be rotated in four 90° steps
Heavy-duty coil designed to UL Standards
Soft synthetic inserts for bubbletight operation, no packing of any type to cause leakage
Extra-heavy stainless steel spring for positive closing action
Two 1/4-20 mounting holes

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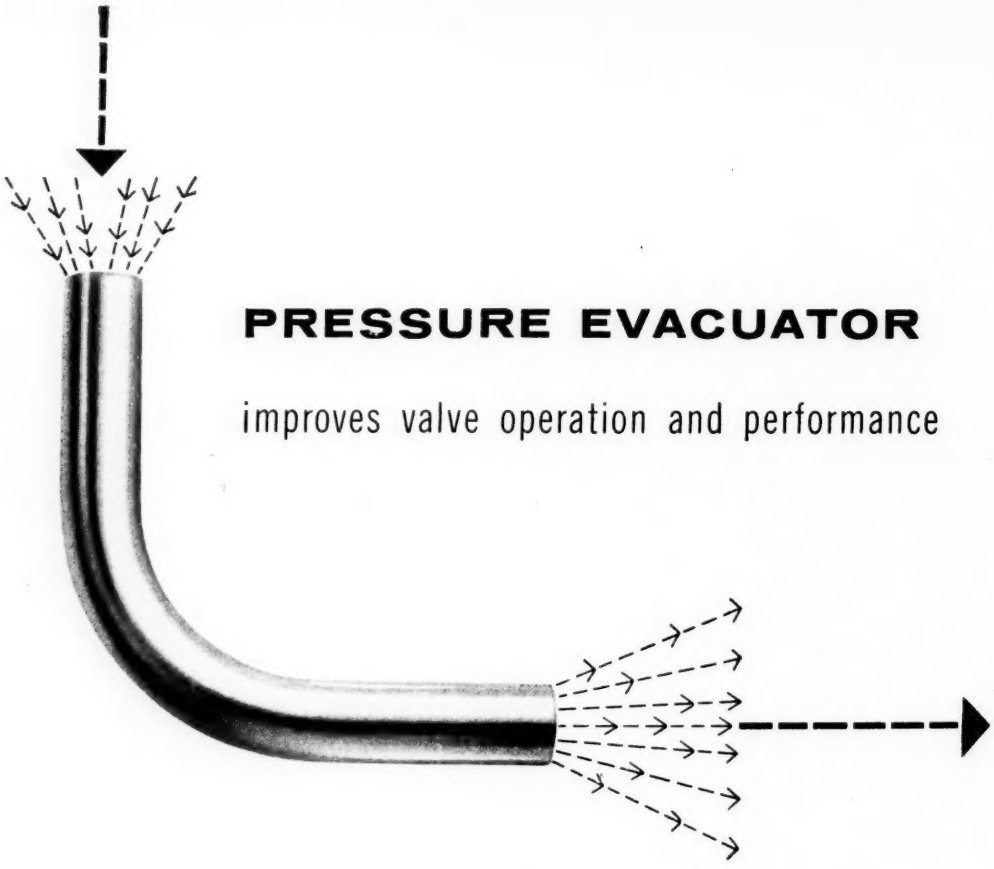
For more information circle **60** on inquiry card.



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improves valve operation and performance

Consolidated Safety Relief Valve, Type 1900 Series, Sizes: 1" x 2" to 8" x 10".

The Eductor Tube in Standard Consolidated Safety Relief Valves is a pressure evacuator. It efficiently removes pressure from the closed bonnet. If allowed to remain in the bonnet, the pressure would act on the top of the disc and tend to limit the lift and induce cycling. But with the pressure evacuated from the closed bonnet through the Eductor Tube, the spring alone controls valve action. Consequently, *reliable* valve action and guaranteed capacity ratings are attained. A new high in operational dependability is assured.

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events

June 2-4

1958 National Telemetering Conference sponsored by the A.I.E.E., A.R.S., I.S.A. and I.A.S., Lord Baltimore Hotel, Baltimore, Md. For information write T. E. Meyers, Wolfe & Mann Mfg. Co., 28th & Sisson St., Baltimore 11, Maryland.

June 4-6

Twelfth National AFCEA Convention and Exhibit, Sheraton-Park Hotel, Washington, D. C. Write William C. Copp, Exhibits Manager, Armed Forces Communications and Electronics Assoc. Convention and Exhibit, 72 W. 45th St., New York 36, N. Y.

June 9-12

1958 Microscopy Symposium sponsored by W. C. McCrone Associates, Del Prado Hotel, Chicago. For information contact W. C. McCrone, Jr., W. C. McCrone Associates, 500 E. 33rd St., Chicago 16, Ill.

June 9-13.

Fourth International Automation Exposition, Congress, Conferences, and Clinics, New York Coliseum. For information write Richard Rimbach Associates, 845 Ridge Ave., Pittsburgh 12, Pa.

June 11-13

Thirteenth Annual Meeting of the Association for Computing Machinery, University of Illinois, Urbana, Ill. For information write to the Assoc. for Computing Machinery, Jim Douglas, Jr., Math. Dept., Rice Institute, Houston, Texas.

June 12-14

9th Annual Conference and Convention, AIIE, at Hotel Statler, Los Angeles, Calif. For further information contact S. J. Ross, 329 E. Green Street, Pasadena, Calif.

June 16-18

Second National Convention on Military Electronics, Sheraton-Park Hotel, Washington, D. C. For information write George Rappaport, Public Relations Director IRE, Inc., 1 East 79 St., New York 21, N. Y.

June 16-20

Symposium on Molecular Structure and Spectroscopy, Dept. of Physics and Astronomy, The Ohio State University. For further information write Prof. R. A. Oetjen, Dept. of Physics and Astronomy, The Ohio State University, Columbus 10, Ohio.

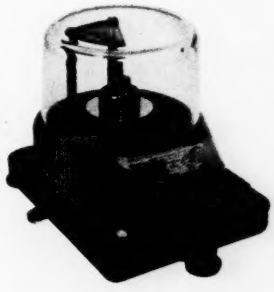
June 16-27

Computer and Management Science Program of University of Michigan consists of eight intensive courses, at Ann Arbor, Mich. For further information contact Co-ordinator of Engineering Summer Conferences, 2038 East Engineering Bldg., University of Michigan, Ann Arbor, Michigan.

industry's new primary pressure standard

. . . calibrates from 0.3 to 500 psi

In one practical instrument, CEC's 6-201 Primary Pressure Standard offers an extended range of precise pressure measurements available in no other similar equipment. Operating as a pneumatic dead-weight tester, the 6-201 offers the advantages of air rather than oil as the pressure medium, extreme accuracy of 0.015% of full range even at pressures of less than one psi, cleanliness and portability regardless of the pressure range. Because this flexible gage or absolute-type instrument depends only on mass and length measurements for its accuracy, it is a true primary pressure standard. It will calibrate any pressure-measuring device. Simple combinations of piston-cylinders and weights provide six pressure ranges within the limits of 0.3 to 500 psi, each with increments of 1%, for both gage and absolute measurements. For additional information, call your nearest CEC sales and service office, or write for Bulletin CEC 1581-X11.



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25 Traces
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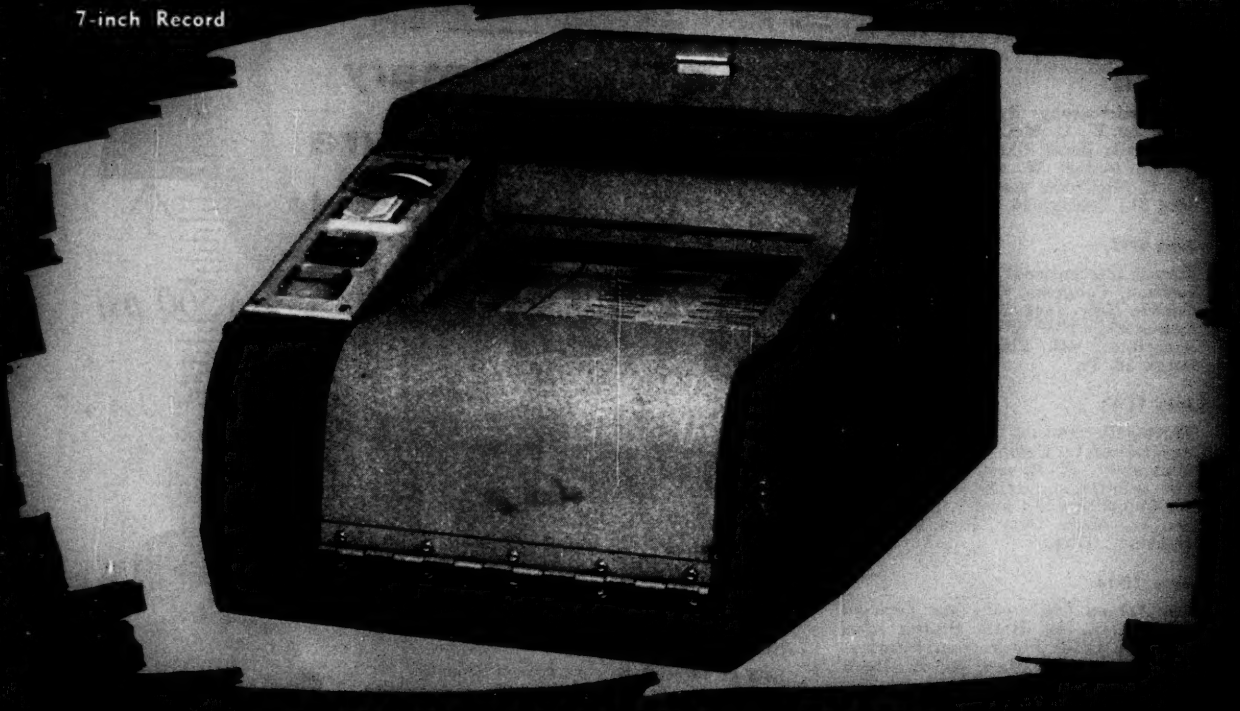

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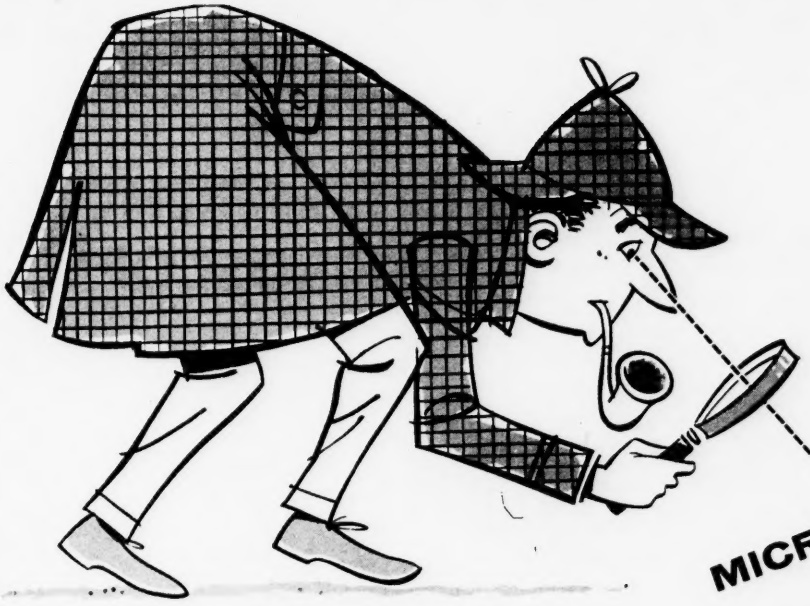

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Dept. IA-5

Please send me Bulletins IA and IB, described above.

Firm Name.....

Address.....

City.....Zone.....State.....

Your Name.....Title.....

For more information circle **64** on inquiry card.

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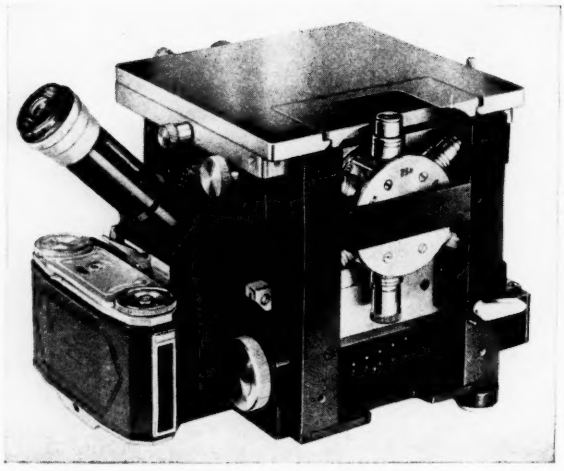

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For accurately measuring minute depths of roughness of super-finished surfaces, thickness of coatings, changes of surface structures due to wear, impact, stress, strain, corrosion, as well as for the studying of polished and etched metallurgical specimens.

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EVENTS

—Continued from page 78,

June 22-27

Fourth Annual Automation Seminar, The Pennsylvania State University, University Park, Penna. For further information contact Chester Linsky, Charge of Automation, The Pennsylvania State University, University Park, Penna.

July 14-25

Special Summer Program in the Physics of Infrared Radiation, Massachusetts Institute of Technology. For information write Dr. Richard C. Lord, Dir. of Spectroscopy Laboratory at M.I.T.

July 24-25

Fifth Annual Symposium on Computers and Data Processing sponsored by the Electronics Div., Denver Research Institute, University of Denver, at Albany Hotel, Denver, Colo. For information write C. A. Hedberg, Head Electronics Div., Denver Research Institute, U. of Denver, Denver 10, Colo.

July 28-August 1

Gordon Research Conference on Instrumentation, Colby Jr. College, New London, N. H. For information write Dr. W. George Parks, Dir., Dept. of Chemistry, University of Rhode Island, Kingston, R. I.

July 29-31

3rd Annual Exhiborama and 2nd Annual Symposium, Society of Photographic Instrumentation Engineers, at Statler Hotel, Los Angeles. For further information contact Bob Jakobsen, Jakobsen Advertising Agency, Inc., 2201 Park Drive, Los Angeles 26, Calif.

August 13-15

7th Annual Conference on Industrial Applications of X-ray Analysis at Albany Hotel, Denver, Colo. For further information contact William M. Mueller, Metallurgy Div. Denver Research Institute, University of Denver, Denver 10, Colo.

August 19-22

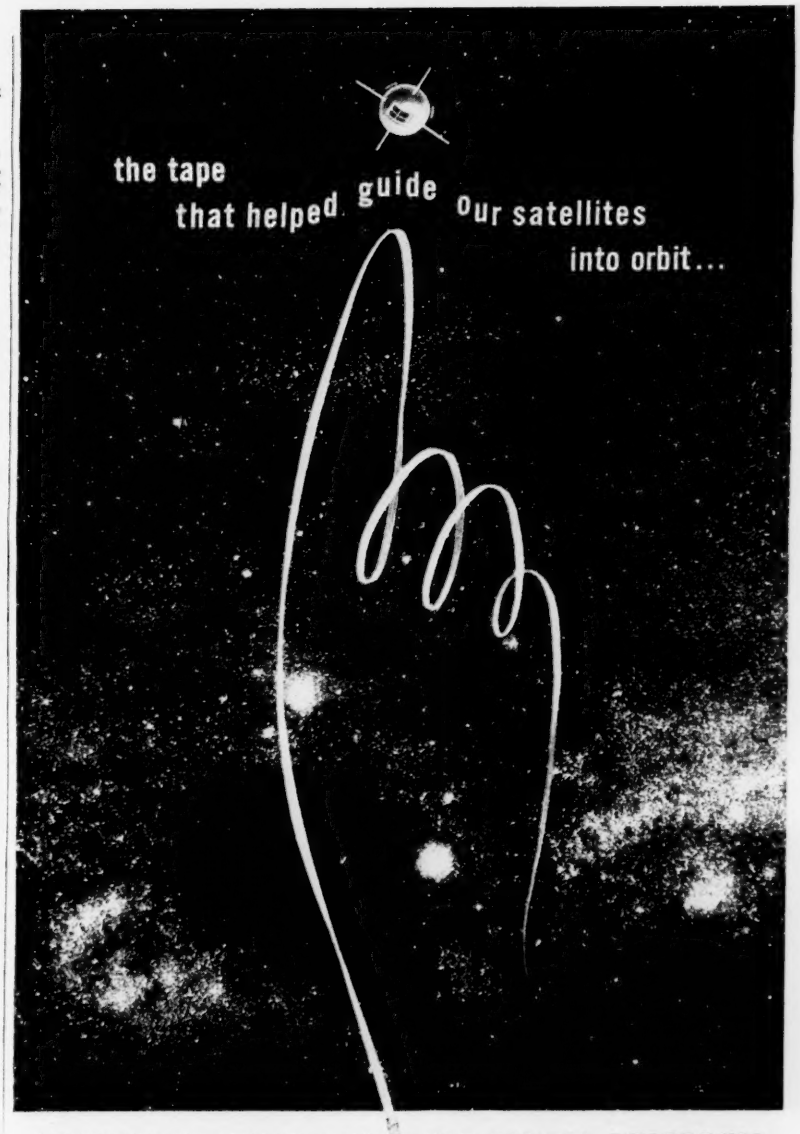
Exhibition of Scientific Instruments and Apparatus at Physics Dept. of the University of Adelaide, Australia, sponsored by The Institute of Physics. For further information contact J. H. Lindsay, 1 Hawke St., Linden Park, South Australia.

Sept. 15-19

13th Annual Instrument Society of America Conference and exhibit will be held in Philadelphia. For further information contact H. S. Kindler, Dir. of Technical Programs, Instrument Society of America, 313 Sixth Avenue, Pittsburgh 22, Pa.

Oct. 13-15

1958 National Electronics Conference —the 14th Annual Forum on Electronic Research, Development and Application sponsored by the American Institute of Electrical Engineers, Illinois Institute of Technology, Institute of Radio Engineers, and Northwestern and Illinois Universities, Hotel Sherman, Chicago. For information write National Electronics Conference publicity chairman, c/o Illinois Bell Telephone Co., 208 W. Washington St., Chicago 6, Ill.



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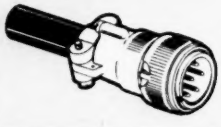

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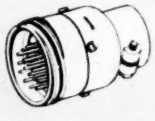

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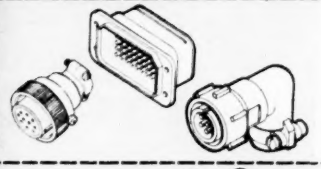

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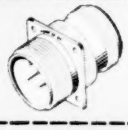

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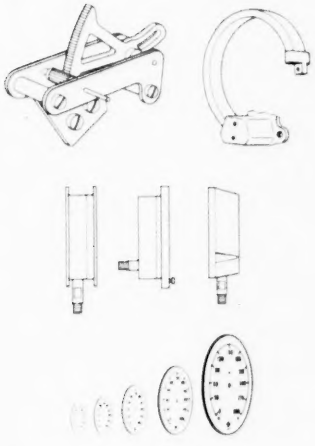

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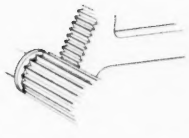

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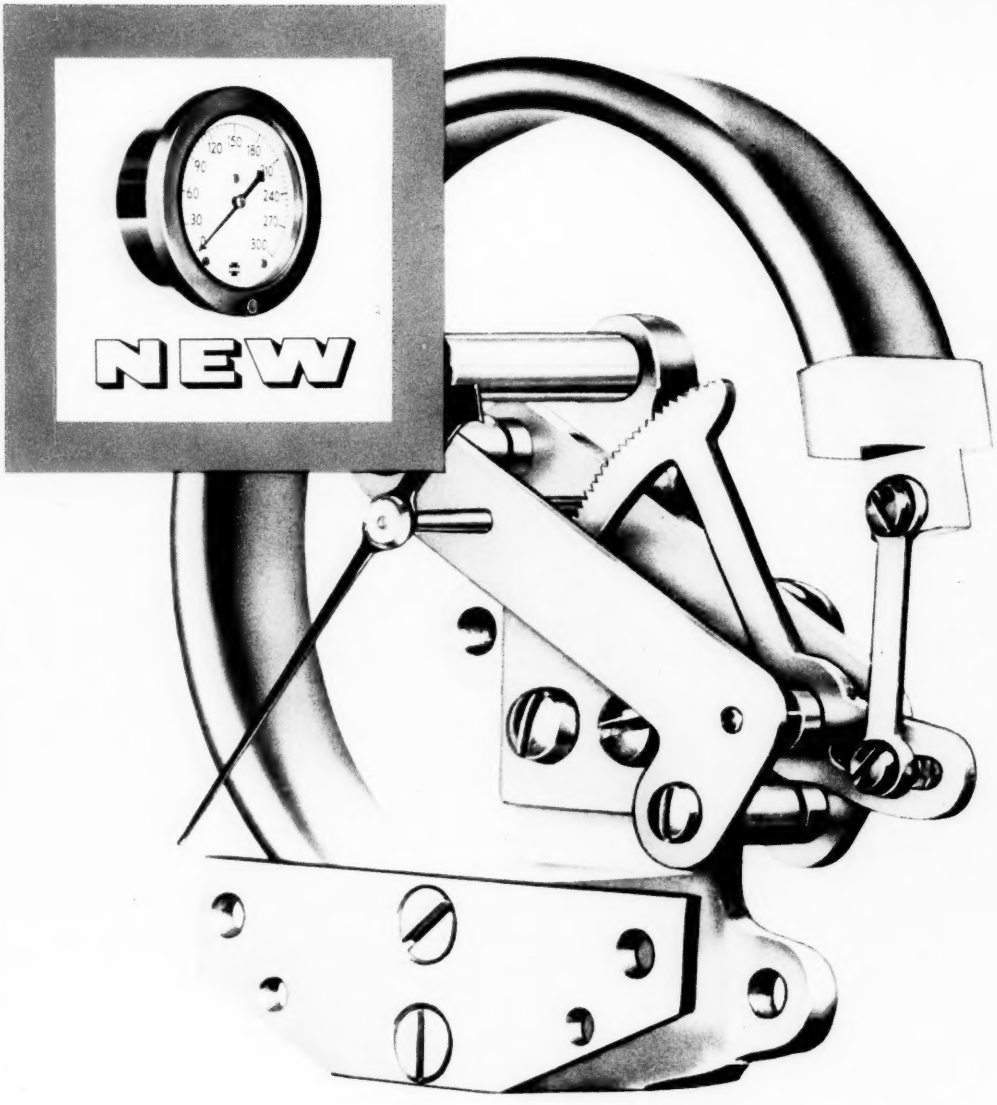

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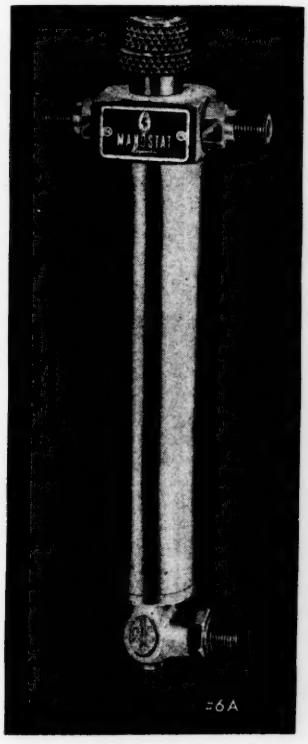

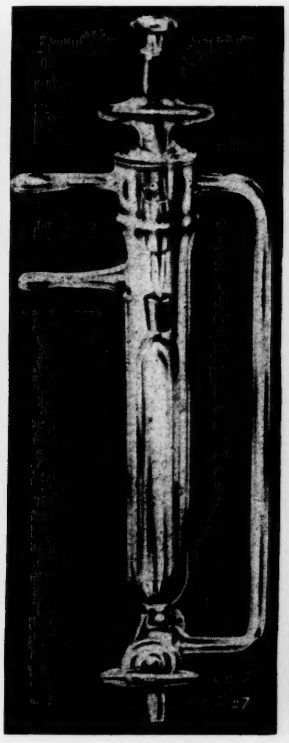

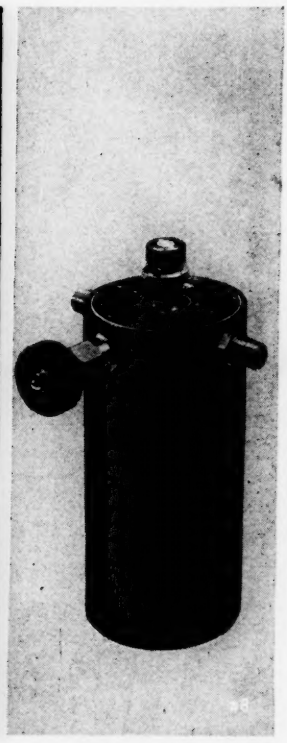

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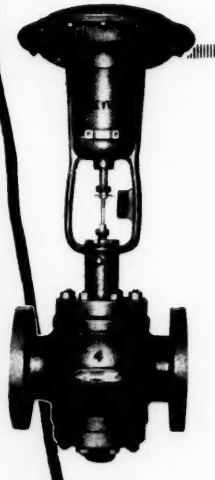

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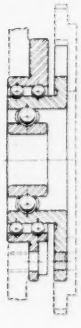
1200% GAIN IN GYRO ACCURACY WITH NEW DEPARTURE BALL BEARINGS!

Sperry C-11 Gyrosyn® Compass with Rotorace bearings will give ultra-precise navigation to the new jetliners.

A major advance in gyroscope construction by Sperry Gyroscope Company results in a remarkable reduction of random drift rate. Involving a special design of gimbal bearings, rates of 2 to 3 deg. per hour, recently considered very good, are now cut to as little as 0.25 deg. per hour with still lower rates in sight.

New Departure created the special manufacturing techniques for the high-precision production of unique ball bearings—another indication of New Departure's ability to meet exacting instrument bearing requirements thru wide engineering experience and precision manufacturing facilities.



The Sperry Rotorace (TM) Gyroscope employs two bearings, one concentric within the other. One outer race is fixed to the gimbal frame, while the other carries a light gear by which it is rotated in periodically alternating directions.

In addition to reducing random drift due to any microscopic irregularities or possible foreign particles, rotation of the bearing race also reduces bearing static or break-away friction.

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MODEL RE-12
FOR 19" RACK MOUNTING

RECORDER ELEMENT, MODEL M-133A
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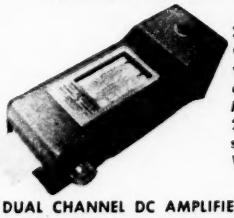
- Event Marker provides automatic one second markings.
- Remote operation with convenient plug-in control unit.
- Footage Indicator shows remaining amount of chart in recorder.
- Dimensions, 19" wide x 12¼" high x 16" deep. Weight 56 lbs.

Write for RE-12 Product Data Sheet

AVAILABLE EQUIPMENT AND ACCESSORIES



2 CHANNEL RECORDER MODEL GA-1023 — Compact, lightweight recorder, for ink or electric writing, employs two M-133 oscillographs. 3 Speeds 2, 20, 200 mm/sec. Dimensions 13"L x 4 3/8"W x 4½"H. Weight: 9 lbs.

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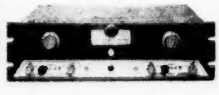

RECORDER ACCESSORIES — Electric Power Supplies for electric writing. Chart rolls with true rectangular coordinates for ink and electric writing. Pens for ink or electric writing.

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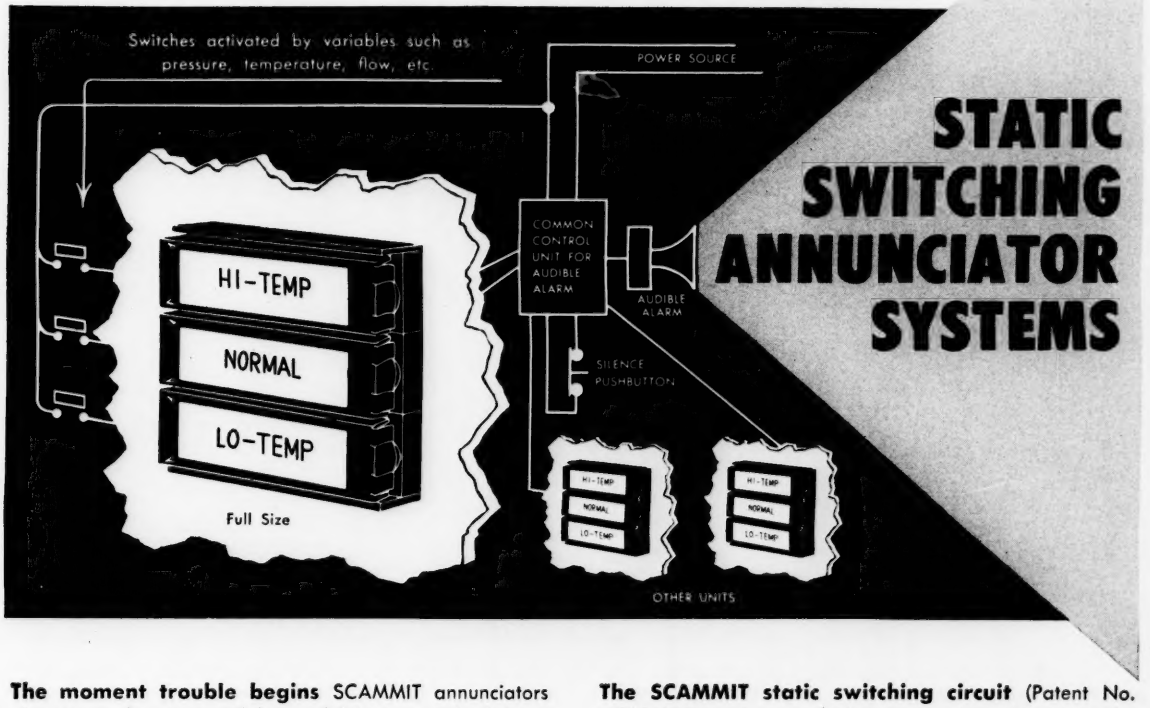

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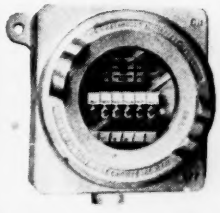
Model ST-FM — For flush mounting, 6 or 8 alarm points; 6-24 Volts, AC-DC.

Model ST-SM—For surface mounting, 6 to 8 alarm points; 6-24 Volts, AC-DC.



Model ST-EM — Miniature explosion proof, suitable Class 1, Div. 1. 6 alarm points; 120 Volts, 60 cycle standard.

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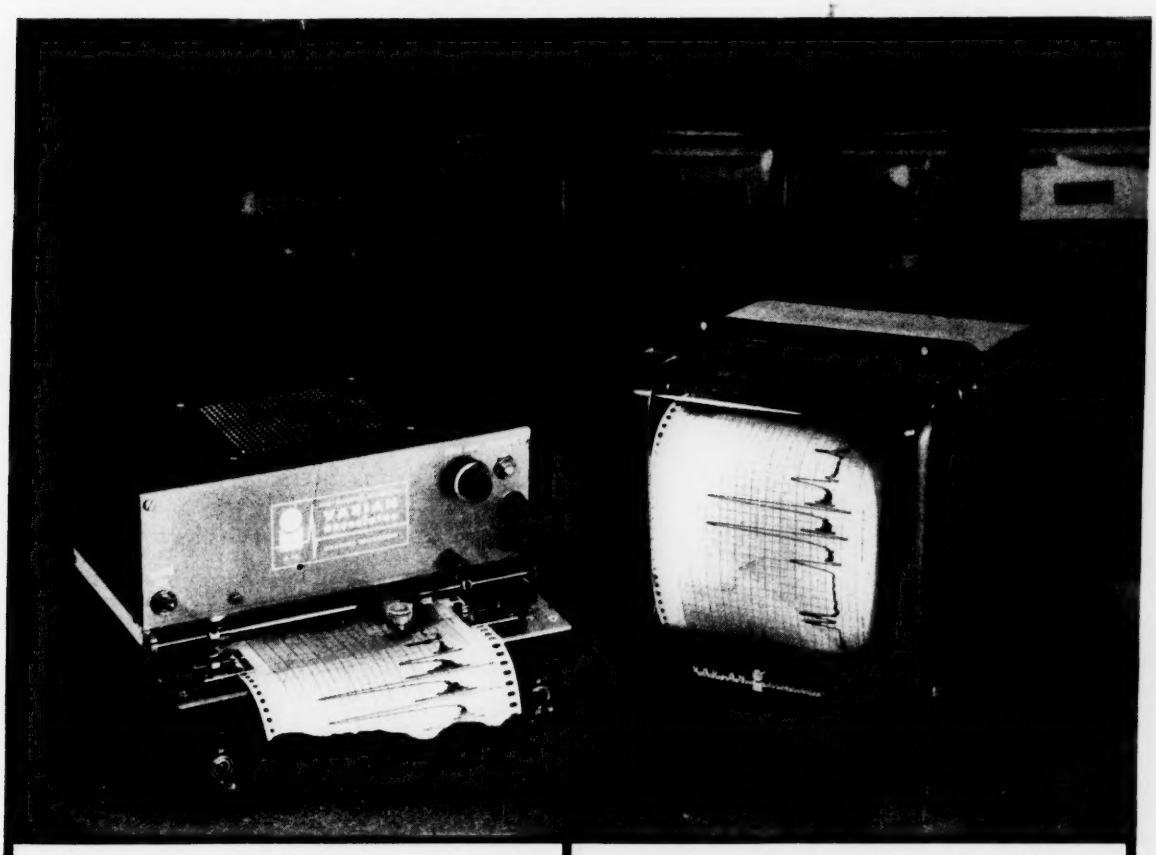
Varian Strip Chart Recorders

POTENTIOMETER PERFORMANCE* AT MODERATE COST



Varian G-10 — Portable for laboratory or bench use where chart accessibility is of prime importance. Base price $340.

Varian G-11A — For panel, rack or portable use; designed for OEM, lab or field for long-term monitoring. Base price $450.

* The servo-balance potentiometer method has long been used in expensive recorders to achieve superior stability, sensitivity, ruggedness and high input impedance. Use of servo balancing systems assures full realization of these inherent advantages by providing ample power independent of the source being measured. Now Varian offers you recorders of moderate cost using this time-proven principle.

VARIAN SPECIFICATIONS:

- Spans as low as 10 mv
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- Maximum source resistance 50K ohms or higher
- Balancing times: 1 second or 2.5 seconds on G-10; 1 second on G-11

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Varian recorders are sold and serviced throughout the free world by representatives in principal cities.

VARIAN associates
INSTRUMENT DIVISION
PALO ALTO 27, CALIFORNIA

Varian Associates manufactures Klystrons, Traveling Wave Tubes, Backward Wave Oscillators, Linear Accelerators, Microwave System Components, R. F. Spectrometers, Magnets, Magnetometers, Stalos, Power Amplifiers and Graphic Recorders and offers research and development services.

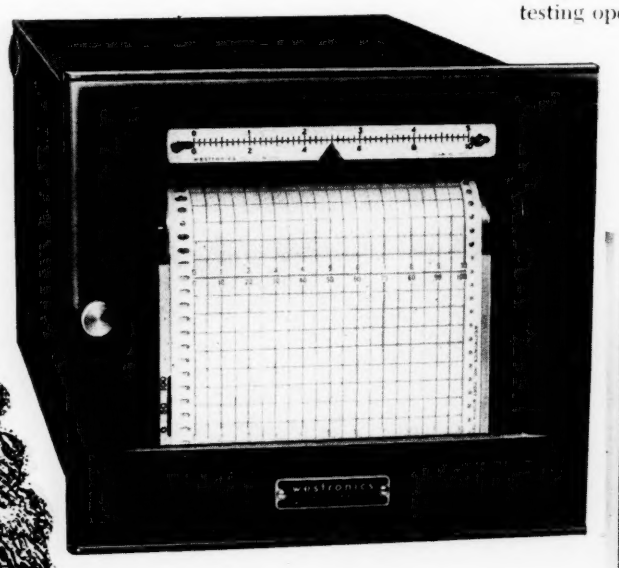
For more information circle **75** on inquiry card.

When seconds make history...

be sure that your data is accurate. Westronics' rugged Single Pen* Miniature Recording Potentiometer is better than 0.5% accurate, with a one second full scale pen travel.

This compact recorder, fits in 9¾" x 8½" panel space, has more optional features than any other small recorder built today. The front and back set limit switches, plug-in range units and transmitting slidewire are among the optional features of the Westronics Single Pen Miniature Recording Potentiometer which adapt this recorder to a variety of uses.

The recorder is widely used by many industrial plants and missile testing operations.



PRICED ONLY $490.00

IMMEDIATE DELIVERY

Send for literature

*Miniature Dual Pen Recorders of same dimensions also available.

westronics INCORPORATED

FORT WORTH, TEXAS 3605 McCART STREET Phone WA 3-8211

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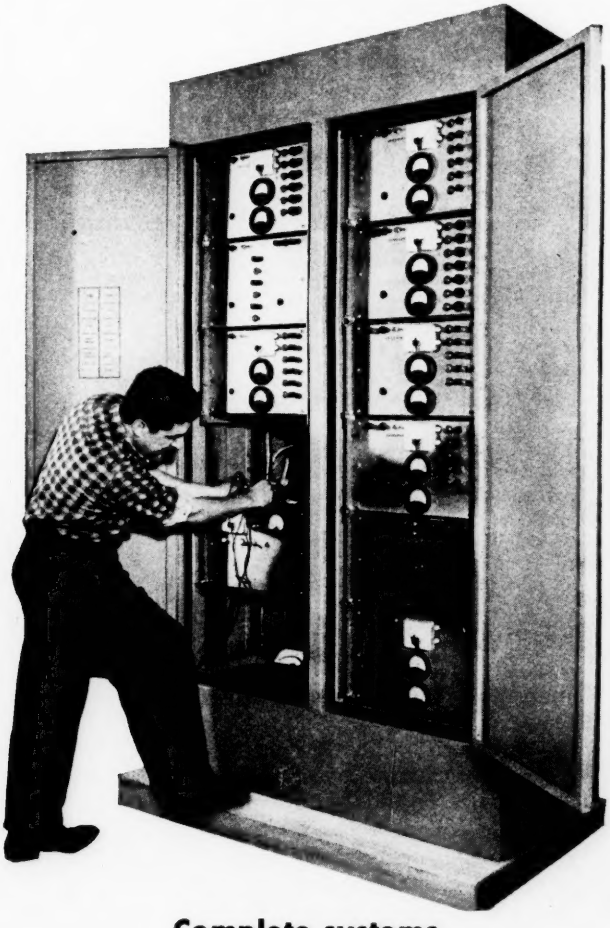
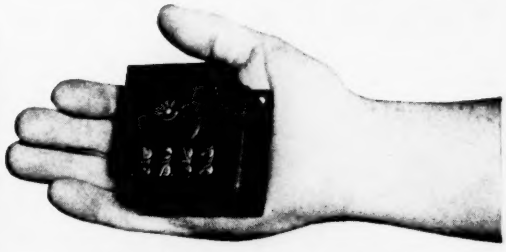
Save design time, avoid assembly headaches with General Electric custom-designed DC power supplies

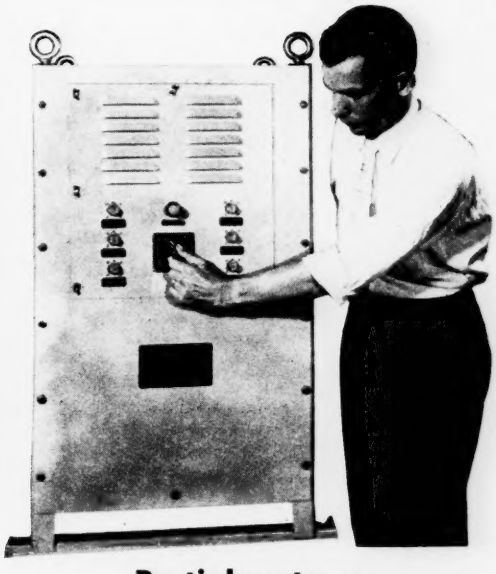
NO PROBLEM TOO GREAT . . . **. . . NO PROBLEM TOO SMALL!**



Complete systems



Individual packages



Partial systems

Subcontract your power supply problems to General Electric! Whether your requirements can be met by the existing, completely engineered supplies we have on hand—or involve custom-packaging of "building blocks"—or call for altogether new designs—give us the power supply *system* responsibility! Consult your local Apparatus Sales Office, or write for bulletin GEA-6690 to Section E 465-5, General Electric Co., Rectifier Dept., Lynchburg, Va.

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GENERAL ELECTRIC

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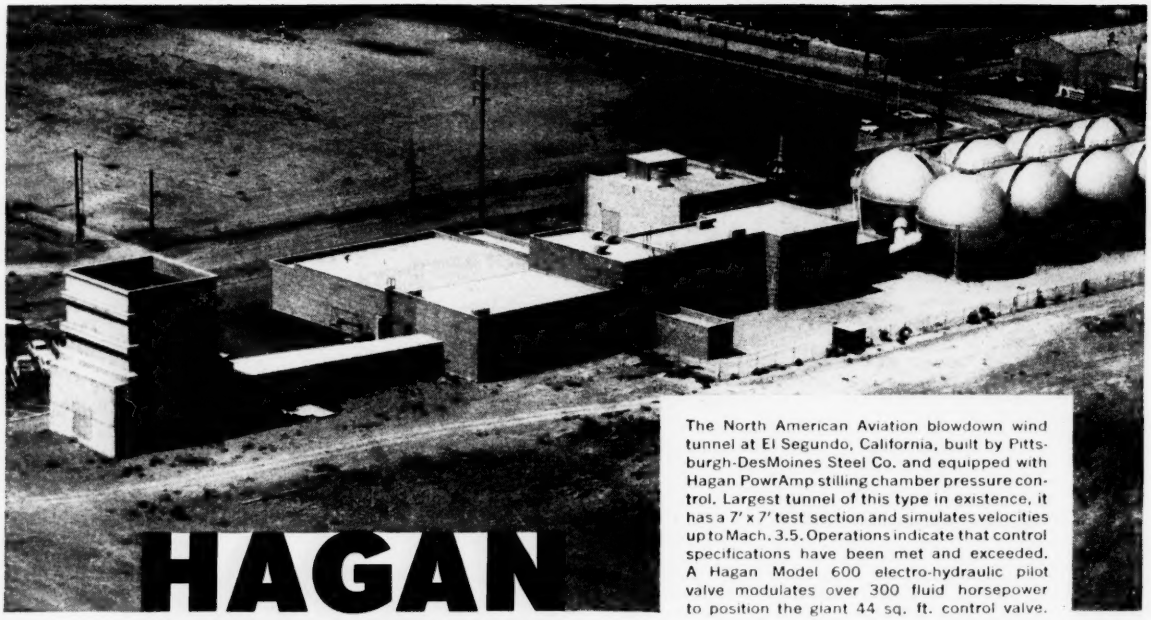
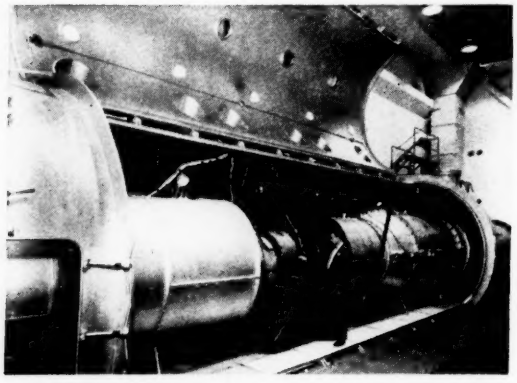


The North American Aviation blowdown wind tunnel at El Segundo, California, built by Pittsburgh-DesMoines Steel Co. and equipped with Hagan PowrAmp stilling chamber pressure control. Largest tunnel of this type in existence, it has a 7' x 7' test section and simulates velocities up to Mach. 3.5. Operations indicate that control specifications have been met and exceeded. A Hagan Model 600 electro-hydraulic pilot valve modulates over 300 fluid horsepower to position the giant 44 sq. ft. control valve.

HAGAN CONTROLS keep pace with the Missile Age



Engine altitude test chamber at Pratt & Whitney's Wilgoos Laboratory simulates flight conditions at high altitudes. The many giant exhausters and compressors which produce these conditions are protected by Hagan automatic surge control systems utilizing Hagan pressure-ratio computers. In addition, engine inlet conditions simulating high speed flight are maintained automatically with a Hagan PowrAmp pressure control system.

Hagan's PowrAmp control components and systems are in successful operation on wind tunnels, including many blowdown tunnels, on engine test cells and missile component test cells. Hagan controls have been selected for these critical installations because of their ability to handle heavy duty tasks with laboratory accuracy.

The PowrAmp line includes transducers for most key variables, electronic control computers and pneumatic, hydraulic and electro-hydraulic operators and pilot valves. All of these are high precision devices which are designed for fast, accurate operation. They are rugged and powerful; the electro-hydraulic pilot valves, for instance, will handle up to 300 usable hydraulic horsepower.

Write for Bulletin MSP-133, which describes the complete PowrAmp line in detail.

From this control room at Wyle Laboratories component test facility in Los Angeles, Hagan controls produce programmed missile fuel flow simulations to test rocket engine components for America's mightiest missiles.

These installations represent only a few of the hundreds of successful Hagan installations in wind tunnels, engine test cells and aircraft and missile test facilities.

HAGAN CHEMICALS & CONTROLS, INC.

HAGAN BUILDING, PITTSBURGH 30, PENNSYLVANIA
DIVISIONS: CALGON COMPANY, HALL LABORATORIES
IN CANADA: HAGAN CORPORATION (CANADA) LIMITED, TORONTO

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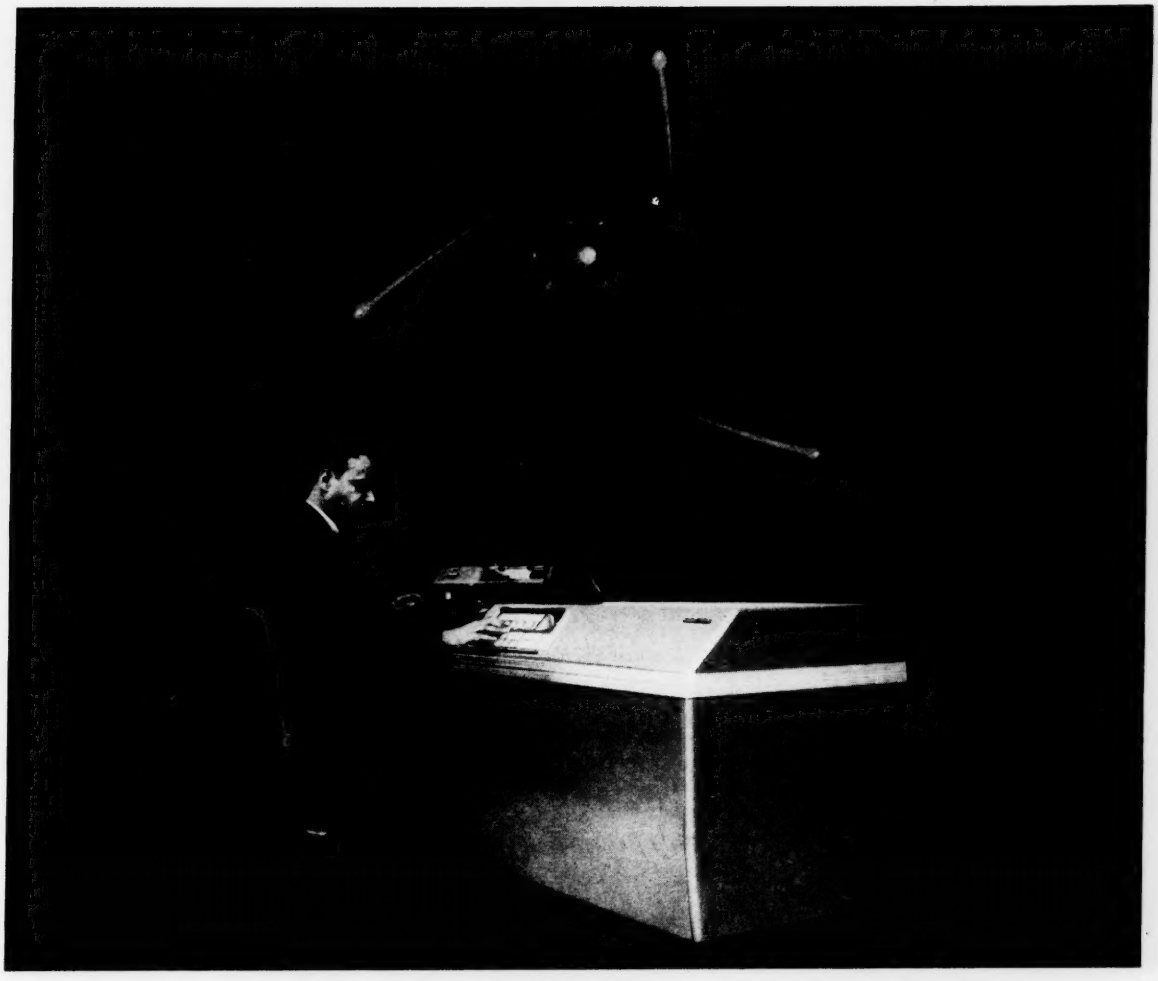

At last! A large-capacity electronic computer you use right at your desk! ROYAL PRECISION LGP-30

High-speed computation at the lowest cost ever for a complete computer system

No more waiting in line for those answers you need! No more lost time in executing preliminary calculations or modifying equations! Not with the LGP-30! Wheeled right to your desk, operated from a regular wall outlet, LGP-30 allows you to follow your work personally from beginning to end . . . to change formulae on the spot . . . to simulate optimum designs without weeks of mathematical analysis. Thus you get faster answers . . . added time for *creative* work.

Easy to use. LGP-30 is a general-purpose stored-program computer — internally binary, serial, single address. Just the few orders in the command structure give complete internal programming. Controls are so simplified, you get an "overnight" feel for your computer.

Unusual memory capacity. With a magnetic drum memory of 4096 words, LGP-30 is the most powerful computer of its size yet developed. Fully automatic, it executes self-modifying programs.

Exceptional versatility and value. Both the scope of LGP-30's applications and the range of calculations it can perform are almost limitless. It gives speed and memory equal to computers many times its size and cost, yet initial investment is the smallest ever for a complete computer. Maintenance costs are extremely low . . . service facilities available coast-to-coast.

Outstanding features of LGP-30

• Alpha-numeric input-output via electric typewriter or punched paper tape. • Optional input-output equipment available. • Unusually large memory — 4096 words. • Library of sub-routines . . . programs for wide variety of applications. • Mobile . . . no expensive installation . . . self-cooled. • Nation-wide sales and service.

For further information and specifications, write Royal McBee Corporation, Data Processing Equipment Division, Port Chester, N. Y.

ROYAL McBEE

WORLD'S LARGEST MANUFACTURER OF TYPEWRITERS AND MAKERS OF DATA PROCESSING EQUIPMENT

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Diode Manufacturer uses Electro Instruments X-Y Recorders to plot Zener diode characteristics

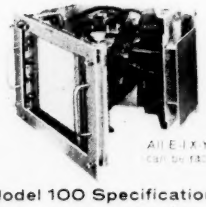
INCLUDES PLOT WITH EACH DIODE

International Rectifier Corporation, manufacturers of Zener diodes, plots the reverse breakdown characteristics of each diode. These plots accompany the diode to the customer and provide an immediately useful graphic description of the individual unit's transfer characteristics. As shown below, the plots are made with an Electro Instruments Model 100 X-Y Recorder.

These proven recorders fulfill the most demanding operational and performance requirements. They possess such advanced design features as transformer-isolated servo-controlled cable drives to eliminate backlash, an internal vacuum hold-down and carriage slewing mechanism for easy paper insertion, and a positive paper indexing provision for measurement repeatability. Operating controls are kept to a minimum and are logically grouped for maximum operator convenience.

the complete line of X-Y Recorders and Data Reduction Accessories

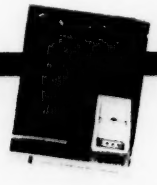
The Model 200 (Computer Output), the Model 215 (Potentiometric Input), Model 225 (General Purpose Plotter) are larger (11" x 17") machines. The basic precision recording capability of these machines is readily expanded to cover more complex input/output data reduction tasks. For this purpose E-I offers a series of auxiliary equipments—Integral Curve Follower, Model 275 Medium Speed Digital to Analog Converter, the Model 250-A Symbol Generator and the Model 260 Time Base Generator.



All E-I X-Y Recorders can be rack mounted

Model 100 Specifications

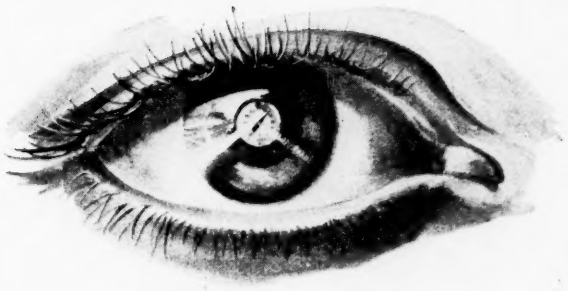
Axes: Independent X and Y isolated axes.
Accuracy: ±0.2% full scale.
Scales: 16 ranges, both axes, from 0.5 mv/inch to 50 volts/inch, mv/inch: 0.5, 1, 2.5, 10, 25, 50, 100, 250 and 500; volts/inch: 1, 2.5, 5, 10, 25 and 50.
Input Resistance: 0.5 mv/inch, essentially infinite at balance with low resistance source; 1.0 mv thru 500 mv/inch, 200 ohms/volt; 1.0 volt thru 50 volts/inch, 2 megohms.
Zero: Full scale zero control with one full-scale length zero offset provided by 10 turn pots.
Reference: Internal mercury battery.
Paper Size: 8-1/2" x 11".
Slewing Speed: Pen 18" sec.; carriage 18" sec.
Power Input: 115v ±10v, 60 cps., 60 watts standby, 125 watts operating.
Dimensions: 10" (max.) high x 12-3/8" wide x 18" deep.



For complete specifications, send for new 4-page brochure

ELECTRO INSTRUMENTS INC.
3540 Aero Court • San Diego 11, California

For more information circle **80** on inquiry card.



What you read is right

The new, patented Maxivision dial on American Bi-Metal Thermometers eliminates the perspective effect of usual pointer-above-dial construction. No parallax! Readings are sure, sharp and accurate – exact working temperatures are always right before your eyes. It is a two-level dial. A raised outer ring, set close to the cover glass, carries the graduations. The index type pointer is on the same plane as the outer ring, with the numerals on a lower level.

What you read is right when American Bi-Metal Thermometers with anti-parallax Maxivision dial are installed at important check points on your processing facilities. Mounting styles, dial sizes, temperature ranges and stem lengths are available to meet the most exacting requirements. Let your nearby industrial distributor help you select the best combination for each location.

American Bi-Metal Thermometer with Maxivision Dial. Suitable for indoor or outdoor service.

MANNING MAXWELL & MOORE INC. TRADE MARK

A2-58R

AMERICAN INDUSTRIAL THERMOMETERS

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Consolidated Ashcroft Hancock Division • Stratford, Connecticut
In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario

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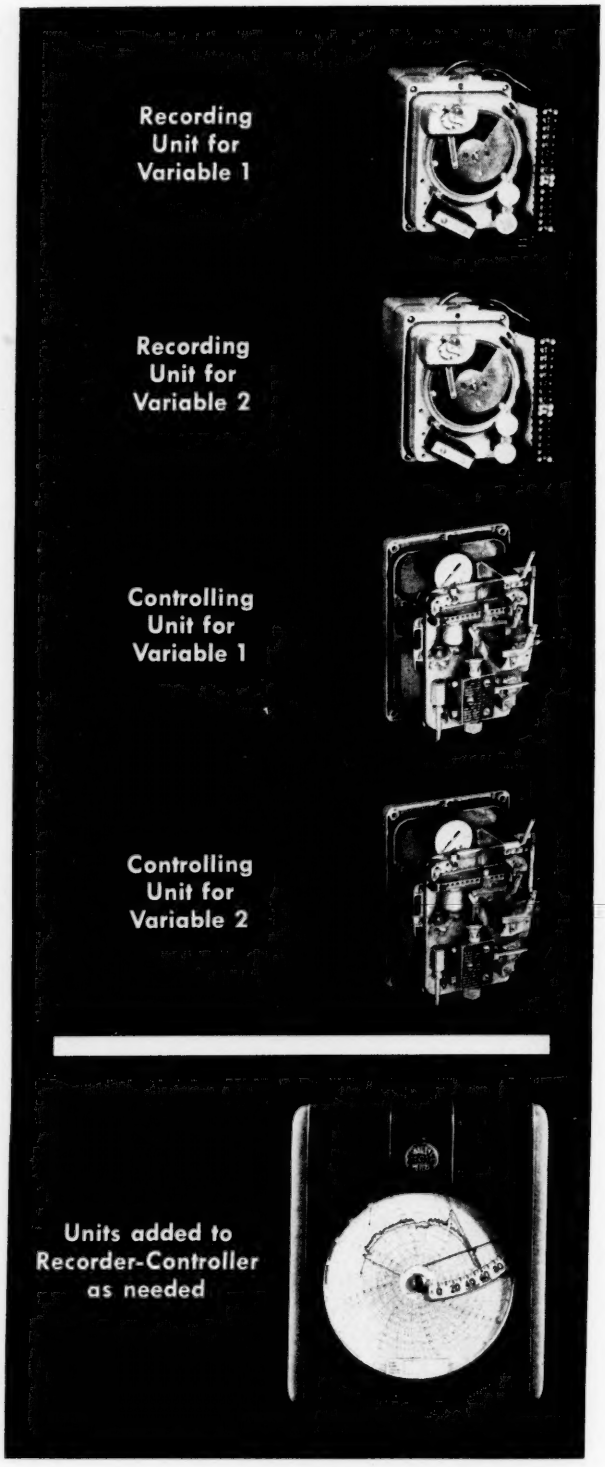
Recording Unit for Variable 1
Recording Unit for Variable 2
Controlling Unit for Variable 1
Controlling Unit for Variable 2
Units added to Recorder-Controller as needed

Bailey Recorder is key to "step-by-step" automation

When you are pioneering a new process and don't know all the answers, complete automation is seldom practical. The first step is to identify your variables and measure them. Nothing does this job better than a Bailey Recorder. One instrument can record any four variables that can be converted to electric *or* pneumatic signals.

Once you get a better understanding of the variables in your process, you will want to add controls and feed back your measurements. Here's where the versatility of the Bailey Recorder comes into play. For the same Bailey instrument you use to record variables is designed to accommodate plug-in control units.

When you use a Bailey Recorder, you can build your instrumentation along with your process. At the start, you use only the plug-in units for recording. Then you add plug-in controls as you see the need for them.

For the complete story of how you can use a Bailey Recorder for step-by-step automation, see your Bailey Engineer.

G-42-1

Instruments and controls for power and process

BAILEY METER COMPANY

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BAILEY METERS

For more information circle **82** on inquiry card.

"This $65 instrument saves me 60¢ an hour in production costs"

TIME RECORDER + TOTALIZER

what TRT is — An instrument that automatically records "on-off" time of **any machine or process.** Information is marked on a continuous, time-indexed tape. Marking stylus is electrically actuated. Tapes run 4 months.

what TRT does — Shows on tape **exactly when** "down-time" occurs, how long it lasts. Access window enables operator to write reason for stoppage. Visual counter totals **actual productive time.**

how TRT saves — TRT data-on-tape gives accurate, single-source basis for **cost-cutting** in plant or office: time study, production control, preventive maintenance, locating bottlenecks. Write for free Brochure FR-5.

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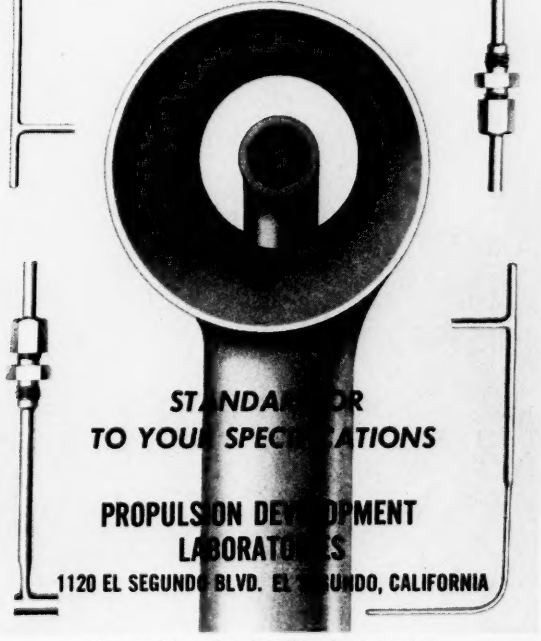
Rakes • Probes
Thermocouples



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control small flows

with finger tip accuracy

on

Aircraft and Automotive Test Stands
Hydraulic Equipment
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Gas Analyzers
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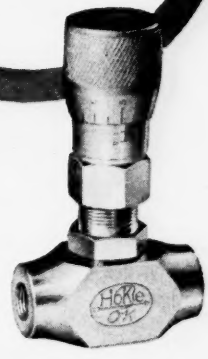
Pilot Plants
Test Instruments

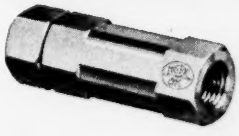


280 SERIES METERING VALVES

Two orifice sizes of 1/16" and 1/8" are available with flow controlled by an 8-degree needle point taking 20 turns to move from open to closed position. In brass with O-ring stem seal or in 316 stainless with Teflon packing. For service to 3,000 psi; operating temperatures from −60° to 450°F. All valves have panel mounting lock nut.

Vernier Modifications

Hoke's #280-25 micrometer hand-wheel kit (illustrated) helps you establish a reference point as to the number of turns required for any flow rate. A low-cost, high-value accessory for precision control.



A SPECK OF DUST

in metered fluid is all it takes to change the orifice setting in Hoke's highly-sensitive 280 Series valve. For critical metering requirements, it's always wise to use this 540 Series Micron Filter to keep foreign matter away from the valve. Complete information on request.

Why buy big when you can buy small

Hoke's Catalog MV-957 has all necessary information on 280 Series Valves and 540 Series Micron Filters. Yours for the asking.

OK

HOKE INCORPORATED
FLUID CONTROL SPECIALISTS
231 South Dean Street
Englewood, New Jersey

For more information circle **85** on inquiry card.

CRESCENT

POLYETHYLENE MULTITUBE

Special Types of Cabled Instrument Tubing To Meet Your Specific Need

These types employ HIGH MODULUS, high density polyethylene tubes made from new low pressure process polyethylene. Four to nineteen tubes of 1/4" OD are SPIRALLY CABLED together under heavy protective coverings which are designed to meet the unusually severe installation requirements with lowest cost.

TYPE XPT-U

Underground and General Purpose Type

Designed for direct earth burial or use in underground conduit and for above ground where subject to moderate mechanical abuse. Tubing is protected by a thick, tough polyvinyl chloride (PVC) sheath resistant to impact, corrosion and flame.

TYPE XPT-F

Flash Fire Resistant Type

A thick PVC sheath, heavy asbestos braid and overall PVC sheath over the tubing assembly provides several minutes of time delay for shutdown in the event of a flash fire. This construction also gives adequate protection from welding and cutting metal splash.

TYPE XPT-FA

Flash Fire Resistant—Armored Type

For complete mechanical protection, the tubing, thick PVC sheath and heavy asbestos braid are covered by an interlocked, galvanized steel armor. Designed for dry locations, type XPT-FA also gives several minutes of time delay in the event of a flash fire.

Send for BULLETIN with complete information.

CRESCENT INSULATED WIRE & CABLE CO.

Trenton 5, New Jersey

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THE RIGHT GAUGE FOR YOUR SPECIFIC NEEDS

Available in a wide variety of general purpose and special purpose gauges in pressure ranges to meet your specifications in every particular.

- PRESSURE
- VACUUM
- COMPOUND
- ALTITUDE
- COMBINATION
- DIAPHRAGM
- HYDRAULIC
- AND SPECIAL PURPOSE GAUGES
- DIAL THERMOMETERS (Vapor Tension or Bi-Metal)

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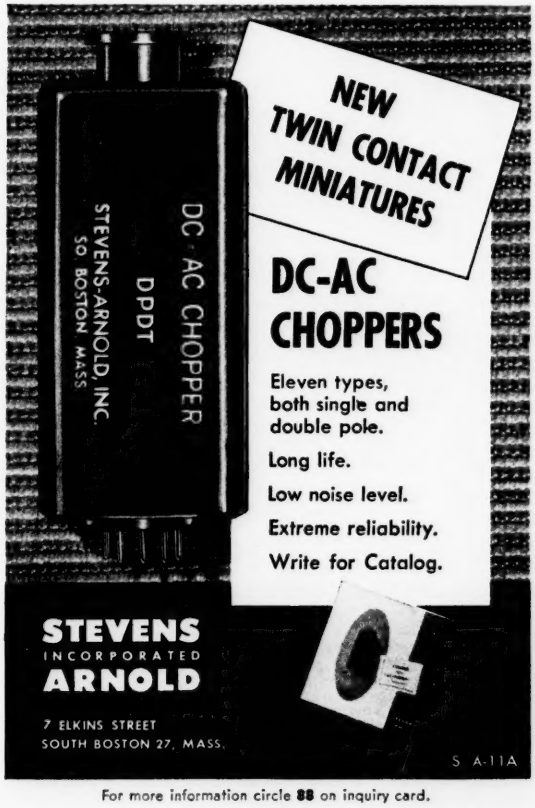

NEW TWIN CONTACT MINIATURES

DC-AC CHOPPERS

Eleven types, both single and double pole.

Long life.

Low noise level.

Extreme reliability.

Write for Catalog.

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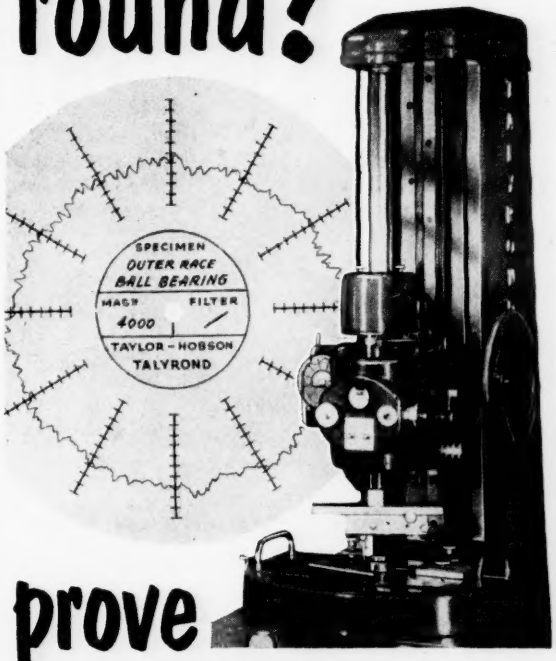
is it really round?



prove it with the... TALYROND

This electronic master instrument measures and records roundness and concentricity on all units of circular cross section.

The Talyrond graphs all deviations from true roundness on balls, rollers, bearing races, valves, gages. Its stylus, carried on an ultra-precision spindle, fully sweeps the part to be checked and provides a permanent inkless record, with radial magnification of 50 to 10,000.

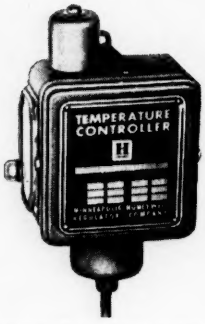
The Talyrond record is your basis for analysis of manufacturing and inspection methods required to maintain reject-free automatic production of circular parts of the highest accuracy.

For complete information without obligation, write Dept TB-58

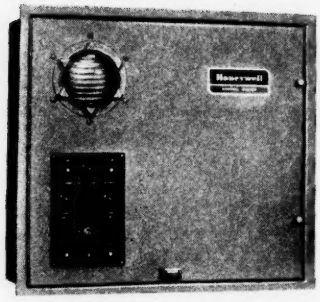
ENGIS EQUIPMENT COMPANY
431 S. DEARBORN STREET CHICAGO 5, ILLINOIS

For more information circle **89** on inquiry card.

PRESSURE CONTROLLERS for high or low-limit cutoff or signalling, or for control of pressure and vacuum in many ranges from 0 to 1000 psi.

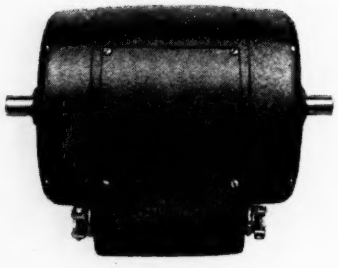


REMOTE BULB TEMPERATURE CONTROLLERS for high or low-limit cutoff . . . signalling . . . and automatic on-off, two-position, floating or proportional control with electrically or pneumatically operated valves, dampers, refrigeration units and similar equipment.



***PROTECTOGLO* FLAME SAFEGUARDS** instantly detect flame failure in gas or oil fired burners, and immediately shut off fuel supply, sound an alarm, and perform other functions to guard against explosion hazards.

Add low-cost automation ...with Honeywell industrial controls



INDUSTRIAL MOTORS for electrical operation of valves, dampers and auxiliary switches.

ALARM SILENCING RELAYS permit an alarm to be silenced, and light an integral red light until an unsafe condition has been corrected. Relay automatically resets the alarm when safe conditions are restored.

You don't have to spend a lot of money for dependable automatic controls. Like many manufacturers, you can use various Honeywell industrial controls as the efficient, low-cost means of automating your equipment . . . improving performance . . . increasing safety. And, you can use these inexpensive controls to save time, money and space by extending automation in your plant or process.

There are more than 9000 standard types of Honeywell controls to handle temperature, pressure, liquid level and humidity—for control, switching or safety functions. There are electric, electronic and pneumatic types.

Though they're low in cost, these controls are top-quality, reliable devices. If there's not already a standard control for your particular application, Honeywell can design and build one for you.

Your nearby Honeywell field engineer will be glad to discuss your control requirements. Call him today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

Honeywell

H HONEYWELL *First in Controls*

NEW OHMITE®

12½ WATT MINIATURE RHEOSTAT

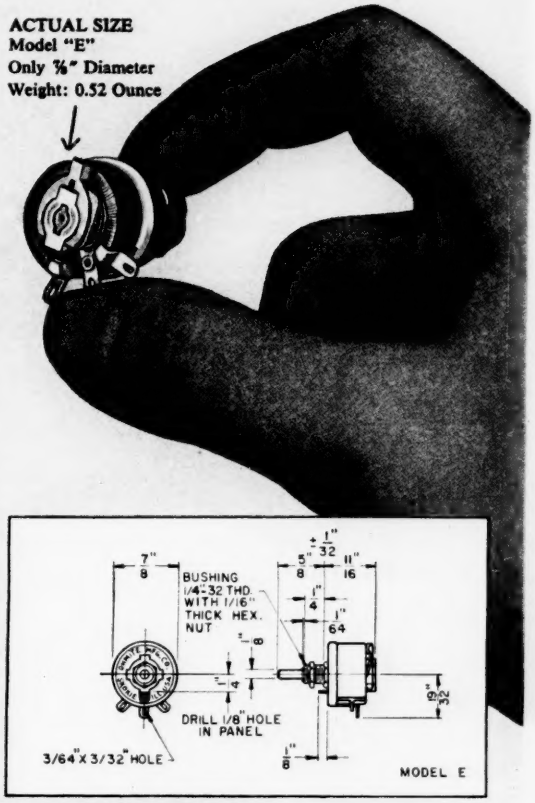
High power handling capability for small size

Newest addition to the Ohmite line of vitreous-enameled rheostats is the new Model "E" miniature 12½-watt rheostat. This new unit is smaller than many one- or two-watt potentiometers. It provides time-tested Ohmite all-ceramic and metal design features for uses where as much as 12½-watt dissipation is required and space is extremely limited. Built to operate at a maximum hot spot temperature rise of 300° C at an ambient of 40° C, Model "E" is also useful for operation at high military ambients, derated linearly to zero at 340° C, attained. Rugged, lasting, power rheostat performance is thus available in such small size that new possibilities in miniaturization and dependability are afforded the apparatus designer.

Like the larger Ohmite rheostats, Model "E" has a ceramic base, and ring-shaped ceramic core. Vitreous enamel holds the turns of wire against shifting, and fastens the base and core together. Also, the Model "E" has a ceramic hub insulating the shaft; a metal-graphite contact; folded spring arm; independent compression spring; slip-ring; a stop directly connected to the shaft. The entire assembly is a miniaturized, dependable version of the time-proven Ohmite power rheostat design. Mounting is by a ¼"—32 threaded bushing. The shaft is ⅛" in diameter. Resistance range: up to 5,000 ohms with 23 stock values; higher values available with OHMICONE inorganic coating. Resistance tolerance: ±10%. Torque: 0.1 to 0.2 pound-inch. A small finger-grip knob, in keeping with the rheostat dimensions, is available.

Special length shafts and bushings, screwdriver shafts, locking type bushing, tandem mountings, enclosures, etc., similar to the variations available on the larger rheostat, can be provided upon specific request.

ACTUAL SIZE
Model "E"
Only ⅞" Diameter
Weight: 0.52 Ounce



INDUSTRY'S MOST COMPLETE LINE OF RHEOSTATS

Now 11 Sizes! — 12½ to 1000 Watts

All sizes available from stock in a wide range of resistance values, including the NEW Model "E." Ten sizes are available to meet MIL-R-22A requirements in *each* of the 26 type designations.

RHEOSTATS RESISTORS RELAYS
TAP SWITCHES TANTALUM CAPACITORS
R. F. CHOKES VARIABLE TRANSFORMERS

OHMITE® QUALITY Components

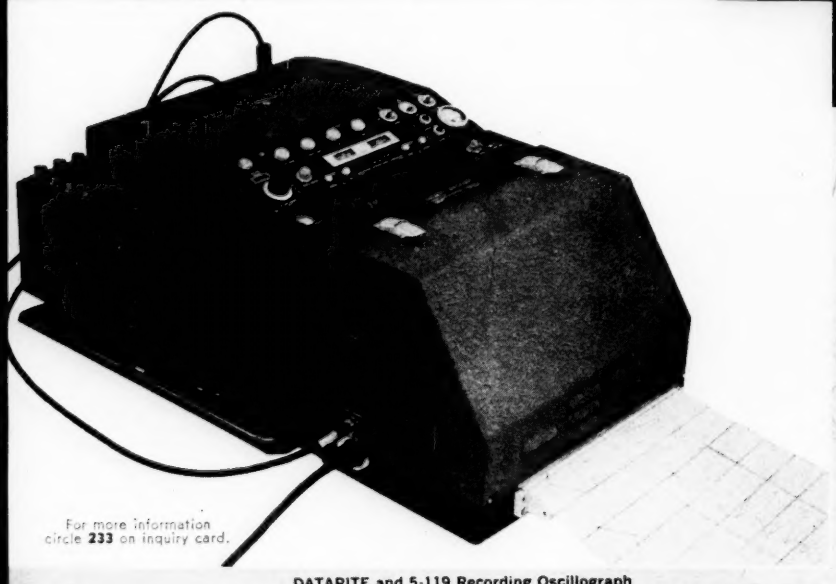
WRITE FOR BULLETIN 157

OHMITE MANUFACTURING COMPANY 3615 Howard Street, Skokie, Illinois

For more information circle **90** on inquiry card.

This is what we mean by
rapid-access
DATARITE

This instrument places visible, developed, dry and ready-to-use oscillograph records in your hands within 0.8 seconds after exposure.



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DATARITE and 5-119 Recording Oscillograph

...*only DATARITE can offer*...visible records at the instant the paper emerges from the magazine exit...no further processing...unmatched trace contrast and clarity...a *true* rapid-access magazine which uses standard commercially available thin-base recording papers ...400-ft. record capacity...internal flash processing with a single chemical solution...no toxic chemical sprays or vapors...standard light source...oscillograms which can be easily duplicated by any conventional process...permanent test results continuously *while* the test is in progress.

DATARITE Magazines directly replace the standard magazines of both the 5-119 and 5-114 Recording Oscillographs without special attachments or modifications.

These combinations provide a unique, transportable recording instrumentation package for on-the-spot analysis of complex military and industrial systems. For complete information on DATARITE – on how to eliminate testing-bottlenecks – contact your nearest CEC field office, or write for Bulletin CEC 1598-X18.

Consolidated
Electrodynamics

300 No. Sierra Madre Villa, Pasadena, California

OFFICES IN PRINCIPAL CITIES THROUGHOUT THE WORLD

EXHIBITORS and their PRODUCTS

ACTON LABORATORIES, INC., Acton, Mass. **813, 815**
Exhibiting: New Products—Transistorized Phase Meter. Regular Products—Phase meters and standards, potentiometer test equip., dual speed drives, impedance measuring Z-angle meters, oscillograph recorders.
For more information circle **301** on inquiry card.

ADCON CORPORATION, Boston 15, Massachusetts **238**
Exhibiting: New Products—Digisyn, Type RD 13 photoelectric shaft position encoder provides angular position data in 13 digit cycle binary code to accuracy of plus or minus 1 digit.
For more information circle **302** on inquiry card.

A'G'A' DIVISION, ELASTIC STOP NUT CORP., Elizabeth, N. J. ... **544**
Exhibiting: New Products—Miniature Agastat Time Delay Relays. Regular Products—Time Delay Relays
For more information circle **303** on inquiry card.

ALDEN SYSTEMS CO., Westboro, Massachusetts **721-723**
Exhibiting: New Products—Cost Cutting Laboratory, to solve cost improvement problems. Regular Products—Work centers, conveyors, fact finders.
For more information circle **304** on inquiry card.

AMERICAN LAUBSCHER CORP., New York 19, New York **633**
Exhibiting: Regular Products—Swiss Automatic screw machine products, centerless ground and polished products, small stampings and stamping dies, pinions, gears, wheels, segments and racks, color-anodized plates, dials, panels and scales, instrument jewels, hair springs and flat springs.
For more information circle **305** on inquiry card.

AMERICAN TELEPHONE AND TELEGRAPH CO., LONG LINES DEPT., New York 7, New York **722, 724, 821, 823**
Exhibiting: New Products—Dataphone Service, high speed transmission of data over regular telephone lines, Type A—Digital Subset, direct transmission at 600 words min., Type B—Recorder Carrier Subset, data recorded "off line" on magnetic tape, transmitted at 800 words min. Can be used with teletypewriter equipment or several types of business machines and computers. Regular Products—SCATS, BELFAST Manual Tape, 81D1, 82, 83B1 and data systems services for communication and data processing requirements by manual, semi-automatic and automatic teletypewriter systems.
For more information circle **306** on inquiry card.

ASKANIA REGULATOR CORP., (GPE), Chicago 11, Illinois **453-553-554-555-556-650**
Exhibiting: New Products—"Electro-jet" units for conversion of low level input signals to hydraulic power for production of thrust or torque in control systems.
For more information circle **307** on inquiry card.

ASSEMBLY PRODUCTS, INC., Chesterland, Ohio **307-309**
Exhibiting: New Products—Model 561 Panel Meters; "Memory" Meter retains readings indefinitely; "Differential" Meter-Relay controls rate and or magnitude of change of a variable; "Proportioning" Control maintains temperatures within total spread of as small as one degree F. Regular Products—Contact meter-relays; All purpose package controls for any variable measureable electrically; Indicating panel meters and pyrometers; VHS non-indicating meter relays.
For more information circle **308** on inquiry card.

AUDIO DEVICES, New York, New York **635**
For more information circle **309** on inquiry card.

AUTOMATIC TIMING & CONTROLS, INC., King of Prussia, Pa. **333-335**
Exhibiting: New Products—306 Atcotrol "Duo-Set" Miniature Repeat Cycle Dial Timer; Relay Controller for use in Atcotran Control System with ATC Linear Differential Transformer Transducers; Digital readout Atcotran "Set-Point Transmitter" for use in Atcotran LOTT Control Systems. Regular Products—Electric, electronic, electro-mechanical and electro-pneumatic timing and sequence devices; Industrial and Military control systems and components
For more information circle **310** on inquiry card.

AVNET CORPORATION, Los Angeles 34, California **447**
Exhibiting: New Products—Connectors
For more information circle **311** on inquiry card.

B & B ELECTRIC MOTOR, New York 12, N. Y. **934**
Exhibiting: Geared and non-geared electric motors
For more information circle **312** on inquiry card.

BAKER CO., INC., Biddeford, Maine **334-431-433**
Exhibiting: New Products—Ultrasonic Cleaner—Models GW-4, GW-5, Air Flow Ball Bearing Torque Tester; Instrument Ball Bearing Tool Kits. Sterilshield pressurized dust free workspaces, torque tester and comparator; ball bearing torque tester
For more information circle **313** on inquiry card.

BALDWIN-LIMA-HAMILTON CORP., Waltham 54, Mass. **422-424-521-523**
Exhibiting: New Products—Disc Indicator for indicating output of SR-4 Load cells, pressure cells, torque pickups. Regular Products—Load cells, pressure cells, torque pickups; Operating model of missile launching platform.
For more information circle **314** on inquiry card.

BARNES DEVELOPMENT CO., Landsdowne, Pa. **813, 815**
Exhibiting: New Products—Deviation and Sorting Bridges, Sorting Mechanisms. Regular Products—Data recorder for testing resistors and electronic components.
For more information circle **315** on inquiry card.

BECKMAN INSTRUMENTS BERKELEY DIV., Richmond 3, California **421-423**
Exhibiting: New Products—1133 Beckman/EASE analog computer with 3600-hole patchboard. Regular Products—General and special purpose analog computers, operational amplifiers, function generators, electronic and servo amplifiers; digital and analog test instrumentation; high-speed counting and timing instruments; frequency meters and nuclear scalers.
For more information circle **316** on inquiry card.

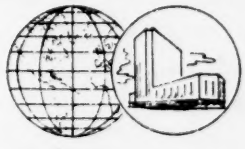
BENDIX COMPUTER DIV., BENDIX AVIATION CORP., Los Angeles 45, California **313-315**
Exhibiting: New Products—Intercom 1000, simplified programming system for the Bendix G-15D Computer. Regular Products—General Purpose Digital Computer G-15D, Digital Differential Analyzer, magnetic tape units
For more information circle **317** on inquiry card.

S. BLICKMAN, INC., Weehawken, New Jersey **539**
Exhibiting: New Products—Controlled Temperature Low Humidity Chamber for precision assembly of small components; Positive Pressure Booth with glove panel for precision assembly of small moving parts. Regular Products—Safety enclosures for handling hazardous substances.
For more information circle **318** on inquiry card.

NORMAN BRAGAR CO., INC., Newark 2, New Jersey **426-428-430-432-434**
Exhibiting: West pyrometric temperature, and saturable reactor controls, scanning systems, thermocouple and lead wire, potentiometer recorders; Scam annunciator systems; Conax HP thermocouple and sealing glands, mineral insulated thermocouples, assemblies; Hope circuit breakers, motor controls, enclosures, cast boxes; Electric Products variable-speed a-c. motors, horizontal, vertical, and synchronous motors, generators, starters, motor generator sets.
For more information circle **319** on inquiry card.

you are invited to attend the "Show of the Future"

JUNE 9-13 FOURTH INTERNATIONAL AUTOMATION EXPOSITION and CONGRESS



EXPOSITION CAPITAL OF THE WORLD

New York COLISEUM

2 to 9 PM, Monday through Thursday, June 9-12, 1958
2 to 6 PM, Friday, June 13

THE EXPOSITION. There is no charge for admission to the Exposition, but registration is required and the badge must be worn while in the Exposition. At-the-show registration will take place at registration desks in the Coliseum main lobby.

EXHIBITORS and PRODUCTS

BRISTOL CO., Waterbury 20, Connecticut **528-530**
Exhibiting: New Products—Dynamaster Recorders for standard 19" relay rack. Regular Products—Dynamaster X-Y recorders, 2-pen recorder, high-speed recorder, Series 663 miniature recorder (d-c potentiometer) and a-c bridge instruments with 3" strip chart.
For more information circle **320** on inquiry card.

BRYANT GAGE & SPINDLE DIV., Springfield, Vt. **237**
Exhibiting: Magnetic Drum Memory System
For more information circle **321** on inquiry card.

BURLINGAME ASSOCIATES, LTD., Mt. Vernon, New York 732-734
Exhibiting: New Products—Analog Computer, Recorders, Computer Components, Digital Instruments, Pulse Equipment
For more information circle **322** on inquiry card.

BURNDY CORP., OMATON DIVISION, Norwalk, Connecticut 622-624
Exhibiting: New Products—HYFEN solderless connectors, and related tooling; HYFEMATIC, automatic machine to connect contacts, wire; STAPIN taper pin panels; UNIRING sheath connector. Regular Products—Compression connectors, terminals, splices, tooling.
For more information circle **323** on inquiry card.

CLARY CORPORATION, San Gabriel, California **634**
Exhibiting: New Products—Data Printers operate from decimal contact closures or from binary coded decimal logic. Regular Products—Parallel-entry numerical data printers, serial-entry numerical data printers, time-data printers, printing timers, tape perforators.
For more information circle **324** on inquiry card.

CLIPPARD INSTRUMENT LAB., INC., Cincinnati 39, Ohio **231**
Exhibiting: New Products—Miniature 4-Way Air Valve, push button, cam or solenoid operated; Miniature quick-connect for ¼" tubing; 9/16" bore air-hydraulic cylinders. Regular Products—Miniature cylinders, valves, manifolds, fittings, accessories. Automatic resistance comparator, automatic capacitance comparator, R. F. coils and electronic sub-assemblies.
For more information circle **325** on inquiry card.

COBEHN, INC., Caldwell, New Jersey **213**
Exhibiting: New Products—Automatic Precision Parts Cleaner for precision electronic and electro-mechanical components. Regular Products—Spray cleaning equipment, solvents, instrument oil, carbon ring oil-less air compressors, bearing tweezers.
For more information circle **326** on inquiry card.

COLEMAN ENGINEERING CO., INC., Torrance, California **631**
Exhibiting: New Products—Digital to Analog Positioning System utilizing standard Coleman Digitizer to provide automatic positioning from digital input; Variable Programming Plug provides format changes by means of external jumper wires. Regular Products—Digitizer-decimal, binary, binary coded decimal
For more information circle **327** on inquiry card.

COMPUTER CONTROL CO., INC., Wellesley 57, Mass. **118**
Exhibiting: New Products—FS-10, T-PAC Static Flip-Flop accepts normal 1-mc clocked T-PAC signals as gated input and provides an amplified two-wire static output; SM-10, T-PAC Serial Memory, up to 560 bits of serial storage at a 1mc repetition rate; DU, T-PAC 30 Element Unit Delay Panel, contains 30, 1 usec delays mounted in a panel to take 1 audio unit of a standard 19" radio relay track. Regular Products—M-PAC, DC to 100 KC static digital modular; T-PAC 1-Megacycle dynamic digital modules.
For more information circle **328** on inquiry card.

CONAX CORP., Buffalo 25, N. Y. **426-428-430-432-434**
Exhibiting: New Products—Roll Temperature Thermocouple Assembly, accurate temperatures on moving rolls or surfaces; Miniature Thermocouple Head, for terminating lead wires; Ceramicouple-Magnesium-Oxide Insulated Thermocouples; Electro Gland, for introducing and sealing power leads. Regular Products-High pressure thermocouple and packing glands pipe clamp and quick disconnect thermocouples, midget thermocouple glands, heads, thermowells, and explosive actuated devices.
For more information circle **329** on inquiry card.

CONSOLIDATED RESISTANCE CO. OF AMERICA, Yonkers, N. Y. 925
Exhibiting: New Products—Ultra High Precision Wire Wound Resistors; Miniature Resistance Networks. Regular Products—Precision wire wound, and power resistors.
For more information circle **330** on inquiry card.

CONTROL, A DIVISION OF MAGNETICS, INC., Butler, Pa. **326**
Exhibiting: New Products—Standard Switching Reactor, with nominal volt-ampere ratings of 15, 75, 150, 300, translates inputs to plain logic, switches for a-c or d-c loads. Regular Products—Standard proportioning reactors, transductors.
For more information circle **331** on inquiry card.

A NEW SHOW SERVICE

To make it easier to obtain data on the products you will see at the Fourth International Automation Exposition, a reply card has been bound into this book. If you wish additional information on the products of the exhibitors, circle the number on the card which corresponds with the number under the exhibitor's name. Be sure to fill in your name, title, company name, street address, city, zone and state, before you mail the card.

COPY-CRAFT, INC., New York 7, New York **407**
Exhibiting: New Products—Ormig Selective Data Printers, automatic selection of information from one master for production control, order invoice systems, etc.
For more information circle **332** on inquiry card.

CRAWFORD FITTING COMPANY, Cleveland 10, Ohio **636-638**
Exhibiting: New Products—Swagelok Teflon Fittings, all standard sizes and shapes; Swagelok Knurled Nuts, finger tip, leak-proof seals on glass or plastic tubing; Swagelok Bulkhead Adapter in any machinable metal or plastic. Regular Products—Swagelok Tube Fittings, adapters, connectors, danger signal bull plugs, socket weld fittings, butt weld fittings, thread lubricants.
For more information circle **333** on inquiry card.

CUSHING & CO., Bayside 61, New York **934**
Exhibiting: New Products—Heller ¾ H.P. variable speed motor control; Hanson-Gorrill-Brian packaged thyratron amplifier unit; Ther automatically regulated semiconductor recitifier power supply unit. Regular Products—Variable-speed motor controls, laboratory mixers, pulse and line products, recitifiers, battery chargers, geared and non-geared electric motors
For more information circle **334** on inquiry card.

DIT-MCO, INC., ELECTRONIC DIV., Kansas City 5, Missouri 608-610
Exhibiting: New Products—Model 250F-IM Universal Automatic Functional Tester for testing relay systems involving actuators, solenoids, time delay devices, resistors, relays, etc; Model 2000 Universal Automatic Circuit Analyzer, capacity for testing up to 1980 circuits for continuity and leakage and supplies voltages for energization of relays and other resistive devices automatically. Regular Products—Universal Automatic circuit analyzers, plugboard programmed multiplier sections, automatic functional testers, Militarized portable circuit analyzers.
For more information circle **335** on inquiry card.

ALLEN B. DUMONT LABS., INC., Clifton, New Jersey **409**
Exhibiting: Regular Products—"400 Series" line of oscilloscopes
For more information circle **336** on inquiry card.

DYNAMETRICS CORPORATION, Burlington, Mass. **119-121**
Exhibiting: New Products—Model 5C.G Locator, for determining precise weight and center of gravity of missiles. Regular Products—Force beam, manometers, pressure beam, weight and center-of-gravity device, digital barometer.
For more information circle **337** on inquiry card.

DYNAMIC GEAR CO., INC., Amityville, New York **327**
Exhibiting: New Products—"Dynaco" Miniaturized Stock Gears. Regular Products—Standard precision stock gears; Differentials; Clutches and anti-backlash gears
For more information circle **338** on inquiry card.

ELECTRIC PRODUCTS CO., Cleveland 12, Ohio 426-428-430-432-434
Exhibiting: New Products—Var E. Pack Drive, tachometer feedback maintains constant speed over load range with stepless control through zero speed. Regular Products—Industrial battery charging equipment, synchronous motors and generators, electrolytic motor-generator sets; induction motors, frequency changers
For more information circle **339** on inquiry card.

ELECTRIC SWITCH CORP., Indianapolis 41, Ind. **343**
Exhibiting: "Staley" time cycle controllers and mercury switches.
For more information circle **340** on inquiry card.

ELECTRO DEVICES, INC., St. Louis 13, Missouri **247**
Exhibiting: New Products—Static Annunciator, monitoring and remote control, but contains no moving parts. Control Annunciator, performs all remote functions of DPDT relay and all normal alarm and sequencing functions. Regular Products—Single, multiple and sequential alarm systems
For more information circle **341** on inquiry card.

ELECTRO PRECISION CORP., Arkadelphia, Ark. **832**
Exhibiting: "Digitrol" control system building blocks—amplifiers, servo multipliers, decade counters, servo actuators, etc.
For more information circle **342** on inquiry card.

ELECTRO PRODUCTS LABORATORIES, INC., Chicago 40, Ill. ... **936**
Exhibiting: New Products—Fail-Safe Proximity Pickup Systems; Transistorized Proximity Controls. Regular Products—Proximity pick-ups and controls; Transducers for speed, control, positioning.
For more information circle **343** on inquiry card.

ELECTROMATH CORPORATION, Long Island City 4, New York 625
Exhibiting: New Products—Miniature, single and multi-turn linear and non-linear precision wire-wound and card-wound potentiometers for critical applications. Regular Products—Precision potentiometers
For more information circle **344** on inquiry card.

ELECTRONIC ASSOCIATES, INC. Long Branch, New Jersey **318-320, 417-419**
Exhibiting: New Products—231 R Analog Computer; Automatic Digital Input-Output System; Transistorized Variplotter; Eight Channel Recorder; Magnetic Tape Dataplotter System; 3033B (LP) Dataplotter; Portable Electronic Digital Voltmeter; High Speed Portable Printer. Regular Products—Analog Computers, analog recorders and X-Y Plotters, digital data point symbol and continuous line plotters, analog-to-digital and digital-to-analog computers.
For more information circle **345** on inquiry card.

ELECTRONIC CONTROL SYSTEMS, DIV. STROMBERG-CARLSON, Los Angeles 64, Calif. **531, 533**
Exhibiting: New Products Digimatic Model 202 Point Positioning System; Digimatic Models 191 and 180 Contouring Systems; Astramatic, automatic production quality control system.
For more information circle **346** on inquiry card.

ELECTRONIC MEASUREMENTS CO., Eatontown, N. J. **735**
Exhibiting: Programmable power supplies for testing transistors, tubes, etc.
For more information circle **347** on inquiry card.

ELECTRONIC PRODUCTS DIV., POST MACHINERY CO. Beverly, Mass. **444**
Exhibiting: New Products—Model "SD-IT" Electronic Decade Counter for medium to fast speed operations. Regular Products—Decitron electronic counters.
For more information circle **348** on inquiry card.

ELECTRONS, INCORPORATED, Newark 3, New Jersey **922**
Exhibiting: New Products—High Current Thyratrons with lugged connections for greater reliability. Regular Products—Thyratron and rectifier tubes.
For more information circle **349** on inquiry card.

ELGIN METALFORMERS CORP., Elgin, Ill. **813, 815**
Exhibiting: New Products—Extra heavy metal racks. Regular Products—EMCOR standard modular enclosures.
For more information circle **350** on inquiry card.

ENCYCLOPAEDIA BRITANNICA, INC., New York 17, New York **411**
Exhibiting: Encyclopaedia Britannica
For more information circle **351** on inquiry card.

ENCYCLOPEDIA AMERICANA CORP., White Plains, N. Y. **331**
Exhibiting: Encyclopedia Americana, 30 Vols.; Popular Science, 10 Vols.; Book Shelf for Boys & Girls, 10 Vols.
For more information circle **352** on inquiry card.

ENGINEERED ELECTRONICS CO., Santa Ana, California **546**
Exhibiting: Germanium Transistor Plug-In Circuits; Transistorized Neon Indicator; Digital plug-in circuits; Decade counters; Amplifiers; Stepping switches.
For more information circle **353** on inquiry card.

EPSCO, INC., Boston 15, Massachusetts **336, 338**
Exhibiting: Data Control Systems and Equipment—low-level differential amplifiers, high-speed analog to digital converters, digital recorders.
For more information circle **354** on inquiry card.

ERIE RESISTOR CORP., Erie, Penna. **813, 815**
Exhibiting: Electronic digital counters and timers.
For more information circle **355** on inquiry card.

ERIEZ MANUFACTURING CO., Erie, Pa. **525**
Exhibiting: New Products—Magna-Rolls and Magna-Rails used in conveying and handling of ferrous materials, parts, etc.; V3B line of H-VL Vibratory Feeders for feeding and controlling bulk materials.
For more information circle **356** on inquiry card.

ESS INSTRUMENT CO., Bergenfield, New Jersey **311**
Exhibiting: New Products—Photoelectric Totalizing Counter. Regular Products—Wyd-Angle, Cat's Eye, and Hazegage smoke, furnace, and combustion safeguard instrumentation; Operational recorders; Turbidity instruments; Miniature photoelectric controls.
For more information circle **357** on inquiry card.

FALCON ALARM CO., Summit, New Jersey **248**
Exhibiting: Tank overfill alarms
For more information circle **359** on inquiry card.

FALSTROM COMPANY, Passaic, New Jersey ..... **346 & 348**
Exhibiting: New Products—Control Consoles for Guided Missiles; Tracker Cabinets. Regular Products—Control panels and cubicles, graphic panel consoles, racks, chassis. Weldments in aluminum, steel, magnesium, stainless alloys, copper and brass.
For more information circle **360** on inquiry card.

FARRAND CONTROLS, INC., New York 70, N. Y. **413**
Exhibiting: Inductosyn—automatic control systems.
For more information circle **361** on inquiry card.

FERRANTI ELECTRIC, INC., Hempstead, N. Y. **616**
Exhibiting: Magnetostriction delay lines; Photoelectric tape recorders; Diffration grating linear measuring equipment.
For more information circle **362** on inquiry card.

FLOW ACTUATED CONTROL CO., Englewood, N. J. **248**
Exhibiting: Multi-pump flow controls
For more information circle **363** on inquiry card.

FOTO-VIDEO LABS., INC., Cedar Grove, N. J. **813, 815**
Exhibiting: Power Supplies, tube and transistorized types.
For more information circle **364** on inquiry card.

GAP INSTRUMENT CO., Freeport, L. I., New York **945**
Exhibiting: New Products—Servo Construction System for building servos and gear trains; Step Transmission System, for remote positioning one or a number of reversible motors up to 120 steps per second; Synchro Positioning Unit, with pairs of synchros geared at common ratio hand positioned with repeatability of one minute. Regular Products—Step Transmission, mechanical integrator.
For more information circle **365** on inquiry card.

GEMS CO., Newington, Conn. **248**
Exhibiting: Float-type flow and level switches.
For more information circle **366** on inquiry card.

GENERAL COMMUNICATION CO., Boston 15, Mass. **120**
Exhibiting: Density (specific gravity) measuring-controlling systems
For more information circle **367** on inquiry card.

GENERAL COMPONENTS, New York 51, New York **937**
For more information circle **368** on inquiry card.

GENERAL CONTROLS CO., Glendale 1, California **748**
Exhibiting: New Products—"Klikswitch" snap-action and mercury switches. Regular Products—Solenoid and motor valves, relays, limit controls, counting instruments, switches, time switches, pressure and temperature instruments, rotary and linear type actuators.
For more information circle **369** on inquiry card.

GENERAL ELECTRIC CO., Rectifier Dept., Lynchburg, Va. **833**
Exhibiting: New Products—Controlled Rectifier D-C Power Supply. Regular Products—Voltage stabilized power supplies.
For more information circle **370** on inquiry card.

GENERAL PRECISION EQUIPMENT CORPORATION, New York 38, N. Y. **453-553-554-555-556-650**
Exhibiting: See Subsidiaries—Askania Regulator Corp.; General Precision Laboratories; Kearfott Co.; Librascope, Inc.
For more information circle **371** on inquiry card.

GENERAL PRECISION LABORATORIES, INC., Pleasantville, N. Y. **453-553-554-555-556-650**
Exhibiting: Vidicon Viewfinder Cameras; Closed-circuit TV.
For more information circle **372** on inquiry card.

GENERAL TRANSISTOR CORPORATION, Jamaica 35, New York **728-730**
Exhibiting: New Products—Bilateral and Drift Transistors; Germanium Computer Diodes; Bobbinless Precision Wire Wound Resistors; End View Phototransistors. Regular Products—Transistors
For more information circle **373** on inquiry card.

GERBER SCIENTIFIC INSTRUMENT CO., Hartford, Conn. **843-845**
Exhibiting: New Products—Gerber Variable Scales, Gerber Graph-analogue's, Gerber Data Readers, Gerber Derivimeters and Gerber Equameters
For more information circle **374** on inquiry card.

DATEX DIV., G. M. GIANNINI & CO. Monrovia, California **415**
Exhibiting: New Products—Automatic Batch Control Systems, different formulas selectable from telephone type dial; C-711 Encoder, 1024 positions over 360 degrees; C-900 Encoder, 2400 positions over 360 degrees rotation; CU-102 Control Unit with SP-101A Pressure Scanner, Datex-Monroe Data/Log; SC-101 Input Scanner; T-121 Translator, for use with Encoders; DC-104 Digital Clock, output in hours and minutes. Regular Products—Pressure and temperature logging systems, Encoder display.
For more information circle **375** on inquiry card.

GORN ELECTRIC CO., INC., Stamford, Connecticut **837**
Exhibiting: New Products—"Gornet" and "Gornector" parts and connectors to build printed circuit board packages. Regular Products—Pressure, float and flow switches; Miniature electronic connectors
For more information circle **376** on inquiry card.

GORRELL & GORRELL, Westwood, New Jersey **826**
Exhibiting: New Products—Efficiency Fax Graphic Recorder shows average percentage of use for every instant of entire work shift; Deviation Graphic Recorder shows accumulated production deviation from standard. Regular Products—Multispeed synchronous timers, graphic operations recorders. Electrex power units for facsimile papers.
For more information circle **377** on inquiry card.

GOW MAC INSTRUMENT CO., Madison, New Jersey **626**
Exhibiting: New Products—Gas Chromatography
For more information circle **378** on inquiry card.

GPS INSTRUMENT Co., Newton 64, Mass. **122**
For more information circle **379** on inquiry card.

W. & L. E. GURLEY, Troy, New York **714-716**
Exhibiting: New Products—Reticles, Precision angle measuring devices, special instruments, precision patterns on glass and metal.
For more information circle **380** on inquiry card.

HANSON-GORRILL-BRIAN, INC., Glen Cove, New York **828, 934**
Exhibiting: New Products—Data-Master and Data Linear Automatic Data Loggers. Regular Products—Packaged Thyratron Amplifier Unit, Thyra-Pulse and Thyra-Line products.
For more information circle **381** on inquiry card.

HARVEY HUBBELL, INC., Bridgeport, Conn. **834**
Exhibiting: Wiring Devices and Machine Screws.
For more information circle **382** on inquiry card.

A. W. HAYDON CO., Waterbury, Conn. **822, 824**
Exhibiting: New Products—Electronic Time Delay Relays; Digital and Laboratory Stop Clocks; Stepper, Miniature Timing and Electronically Governed D. C. Motors; Subminiature Repeat Cycle Timers, Time Delay Relays, Elapsed Time Indicators. Regular Products—AC & DC timing motors, custom designed timing devices, elapsed time indicators, intervalometers, repeat cycle timers, stop clocks, time delay relays.
For more information circle **383** on inquiry card.

HEALY-RUFF CO., St. Paul 14, Minn. **248**
Exhibiting: Pressure, purged air and float type pump controls.
For more information circle **385** on inquiry card.

EXHIBITORS and PRODUCTS

HEISE BOURDON TUBE CO., Newton, Connecticut **921-923**
Exhibiting: New Products—Thermal Compensator, precision Bourdon tube pressure gauge automatically compensates for thermal effects. Regular Products—High precision pressure gauges.
For more information circle **386** on inquiry card.

KARL HEITZ, INC., New York 17, New York **612**
Exhibiting: New Products—Robot fully automatic 35mm cameras; ALPA Single Lens Reflex 8 mm movie cameras and lenses for micro- and microphotography; Camex Single Lens Reflex 8 mm movie cameras for medical, research, close-up photography. Regular Products—Primos enlargers; Kern Stereo microscopes and optical flats; Kinoptik 16, 35 and TV camera lenses; Sinar Viewcamera; Omag pocket microscopes; Lindia slidemounts.
For more information circle **387** on inquiry card.

GERALD K. HELLER CO., Las Vegas, Nev. **934**
Exhibiting: Variable-speed motor controls and laboratory mixers.
For more information circle **388** on inquiry card.

HICKOK ELECTRICAL INSTRUMENT CO., Cleveland, Ohio ... **813, 815**
Exhibiting: New Products—RD Industrial Electronic Test Equip. Regular Products—Ruggedized, military and commercial electric meters; deflection meters.
For more information circle **389** on inquiry card.

HOPE ELECTRICAL PRODUCTS CO.
Hillside, N. J. **426-428-430-432-434**
Exhibiting: New Products—Weatherproof & Explosionproof circuit breakers, motor starters, apparatus and instrument enclosures. Regular Products—Cast iron, aluminum and brass boxes for weather-proof and explosion proof applications.
For more information circle **391** on inquiry card.

HYCON EASTERN, INC., Cambridge, Mass. **813, 815**
Exhibiting: New Products—Crystal Filters for frequencies to and above 30 MC. Regular Products—Magnetic tape indexing equipment.
For more information circle **392** on inquiry card.

KENNETH E. HUGHES CO., Union City, N. J. **813, 815**
Exhibiting: New Products—Electronic Digital Counters and Timers; Automatic Production Testing Equipment; Mechanical Amplifiers and Transducers for machine and process automation. Regular Products—Indicating meters, electronic test equip., transformers, EMCOR modular steel enclosures, EECO plug-in circuits, microminiature relays and high temp. ceramic capacitors, fans and blowers, phase standards and meters, amplifiers and recorders, deposited carbon film resistors, crystal filters, tape indexing equip., ultra stable oscillators, power supplies tube or transistor type.
For more information circle **393** on inquiry card.

THE INDUSTRIAL PRESS, New York 13, New York **846**
Exhibiting: Regular Products—Machinery Magazine; Trade papers and engineering books.
For more information circle **394** on inquiry card.

INSTITUTE OF RADIO ENGINEERS, New York 36, New York ... **217**
Exhibiting: New Products—"Transactions", professional group on automatic control. Regular Products—Proceedings of the IRE, IRE Directory, Professional group transactions and convention records.
For more information circle **395** on inquiry card.

INSTRUMENT DEVELOPMENT LABS., Inc., Attleboro, Mass. **726**
Exhibiting: New Products—Miniature Sampling Switch; Inertial Velocimeter. Regular Products—Shaft Angle Converter, PDM and PAM Telemetering Commutators, High Speed Sampling Switch, Color Eye.
For more information circle **384** on inquiry card.

INSTRUMENT MOTORS, Irvington, New Jersey **711**
Exhibiting: New Products—Motors & Generators and Servos
For more information circle **396** on inquiry card.

INSTRUMENTS PUBLISHING CO., INC. **808-810-907-909**
Exhibiting: New Products—INSTRUMENTS & AUTOMATION, INSTRUMENT & APPARATUS NEWS, MEDICAL ELECTRONICS NEWS, MILITARY AUTOMATION
For more information circle **397** on inquiry card.

INTERNATIONAL BUSINESS MACHINES CORP.,
New York 22, N. Y. **639-641**
Exhibiting: Automatic Production Recording Systems
For more information circle **398** on inquiry card.

JARCO SERVICES, INC., Tulsa, Okla. **248**
Exhibiting: Capacitance probe type level controls
For more information circle **399** on inquiry card.

JERROLD ELECTRONICS CORP., Philadelphia, Pa. **735**
For more information circle **400** on inquiry card.

KEARFOTT CO., Clifton, New Jersey **453-553-554-555-556-650**
(See General Precision Equipment Corp.)
For more information circle **401** on inquiry card.

KEY RESISTOR CORP., Gardena, Calif. **813, 815**
Exhibiting: New Products—Hi-Temp. Hermetically Sealed Resistors. Regular Products—Precision Deposited Carbon Film Resistors.
For more information circle **390** on inquiry card.

KURMAN ELECTRIC CO., Brooklyn 22, N. Y. **816**
Exhibiting: Relays.
For more information circle **358** on inquiry card.

LABORATORY FOR ELECTRONICS, Boston, Mass. **735**
For more information circle **402** on inquiry card.

LANDIS & GYR, INC., New York 36, N. Y. **440, 442**
Exhibiting: Miniature Ball Bearings; Impulse Counters
For more information circle **403** on inquiry card.

LARSON INSTRUMENT CO., Tarrytown, New York **437**
Exhibiting: Plug-in Contact Meter Indicating Controls; Inkless Recorder 30 Channel, 3600 times magnification in 5 milliseconds, binary, digital, sequence, on-off recording. Regular Products—Inkless recorders, contact meter controllers.
For more information circle **404** on inquiry card.

LAVOIE LABORATORIES, INC., Morganville, N. J. **709**
Exhibiting: New Products—Automatic Fault Locating Equipment, ROBOTESTER, High Precision Frequency Standards and Measuring Equipment
For more information circle **405** on inquiry card.

GERARD G. LEEDS CO., INC., Great Neck, New York **735**
Exhibiting: New Products—Programmable Power Supplies for automatic testing of transistors, tubes and other electronic components; High Speed Digital Voltmeters, Ohmmeters and fully automatic test systems; "Otrac" Oscillogram Trace Reader; Automatic Mass Spectrometer Leak Detection System; Automatic Vacuum Processing Systems. Regular Products—Products of Daystrom Pacific Corp., Electronic Measurements Co., Jerrold Electronics Corp., Laboratory for Electronics, Magnetic Research Corp., Millivac Instrument Corp., Non-Linear Systems, Inc., Narda Ultrasonic Corp.
For more information circle **406** on inquiry card.

LIBRASCOPE, INC., Glendale, California ... **453-553-554-555-556-650**
Exhibiting: New Products—Computers—Controls and Components
For more information circle **407** on inquiry card.

MACHINERY MAGAZINE, New York 13, New York **846**
(See Industrial Press)
For more information circle **408** on inquiry card.

MARTIN-DECKER CORPORATION, Long Beach 7, Calif. **632**
Exhibiting: New Products—SL and SW load cell systems for measuring compression and tension forces, simplifies load weighing problems. Regular Products—Hydraulic crane scales, lift truck weight indicators, crane weight indicators, test gauges, tensiometers, cable tension indicators, dynamometers.
For more information circle **409** on inquiry card.

MCINTOSH EQUIPMENT CORP., New York 38, New York **248**
Exhibiting: New Products—Variable Flow Type Arkon Flow Indicators for wider flow ranges; Ball Type Arkon-Flow Indicators for lower rates. Regular Products—Warrick floatless electrode type liquid level controls; Healy-Ruff pressure, purged air and float type pump controls; Gems float-type flow and level switches; Jarco capacitance probe type level controls; Falcon tank overfill alarms; Flow Actuated Control multi-pump flow controls; Arkon flow indicators
For more information circle **410** on inquiry card.

McLEAN ENGINEERING LABS., Princeton, N. J. **813-815**
Exhibiting: Fans and Blowers
For more information circle **411** on inquiry card.

METALAB EQUIPMENT CO., Div. Norbute Corp.,
Hicksville, L. I., New York **818**
Exhibiting: New Products—Specialized Laboratory Equipment: Fume Hoods for Radioactive Materials; Chemical Storage Cabinets. Regular Products—Laboratory tables, chemical fume hoods, laboratory fittings and accessories, complete laboratory equipment in metal or wood, natural stone and composition, table tops, sinks and fixtures.
For more information circle **412** on inquiry card.

MICRO SWITCH DIV., MINNEAPOLIS-HONEYWELL
REGULATOR CO., Freeport, Illinois **322-324**
Exhibiting: New Products—"Plug-In-Limit" Switch, instantly replaceable; Modular—mount Pushbutton Switches with two built-in indicator lamps; Proximity Switches, no physical contact; Magnetically-held Lighted Pushbuttons; High-temperature basic switches for long life at 600° F. Regular Products—Precision snap-action switches and assemblies, Mercury switches; Manual toggle, pushbutton and rotary; Splash-proof, explosion proof and hermetically sealed switches; Circuitry in all types.
For more information circle **414** on inquiry card.

MID-CENTURY INSTRUMATIC CORP., New York 12, N. Y. ... **344-443**
Exhibiting: Analog Computors.
For more information circle **413** on inquiry card.

MILES REPRODUCER CO., INC., New York 3, New York **226**
Exhibiting: New Products—"Walkie-Recordall", self-powered conference-dictation recorder, start-stops automatically by actuation of voice or telephone.
For more information circle **415** on inquiry card.

MILLER FLUID POWER DIV., FLICK REEDY CORP.,
Melrose Park, Illinois **545-547-549-551**
Exhibiting: New Products—Model H Power Packed Hydraulic Cylinder for 3000-5000 Psi and Model J Job Rated line; Tru-Seal Leakproof Fittings for threaded connections. Regular Products—Air & hydraulic cylinders; "Miller College of Cylinder Knowledge".
For more information circle **416** on inquiry card.

MYCALEX CORPORATION OF AMERICA, Clifton, New Jersey **117**
Exhibiting: New Products—PC Printed Circuit Commutation Switch with Supramica 560F ceramoplastic commutator plates, for telemetering and data processing. Regular Products—Mycalex glass-bonded mica; Supramica ceramoplastics; Synthamica synthetic mica; Mycalex TM Commutation switches with Supramica 555 ceramoplastic commutator plates.
For more information circle **417** on inquiry card.

NARDA ULTRASONICS CORP., Mineola, N. Y. **735**
For more information circle **418** on inquiry card.

NATIONAL CASH REGISTER CO., Dayton 9, Ohio 522-524-621-623
Exhibiting: New Products—Compu-Tronic, general purpose accounting machine with electronic multiplication for billing, payroll, inventory, etc.

For more information circle **419** on inquiry card.

NEW HERMES ENGRAVING MACHINE CORP., New York 3, New York 906
Exhibiting: New Products—Model I-R Pantographic Engraving Machine for electronic, instrument and sign-making industries; Beveler Portable Edging Machine for plastic or metal name-plates. Regular Products—Portable engraving machines; Bench-type engraving machines; attachment for drilling printed circuits.

For more information circle **420** on inquiry card.

NON-LINEAR SYSTEMS, INC. Del Mar, Calif. 735
Exhibiting: Digital voltmeters, ohmmeters, test systems, OTRAC oscillogram trace reader.

For more information circle **421** on inquiry card.

NORTH AMERICAN VAN LINES, INC., Fort Wayne, Indiana 731
Exhibiting: Improved methods for moving electronic and high value products

For more information circle **422** on inquiry card.

OPTICS MANUFACTURING CORP., Ind. Div., Philadelphia, Pa. 435
Exhibiting: New Products—Fostoria Opta Vue Assembly Viewer, viewing area 36"; Opta Vue Hand-Held Micro Reader. Opta Stat with AS88 Anti-Static compounds to combat static charges. Regular Products—Opta Vue Transparency Viewers, Slide Files, Slide Mounts, Newlo Glass for slide mounting without Newton rings.

For more information circle **423** on inquiry card.

OPTO-METRIC TOOLS, INC., New York 13, New York 243-245
Exhibiting: New Products—Floor Model A-F Wilder Micro-Projector, completely self-contained; Leitz Optical Dividing Head reading to two seconds of arc, accuracy of plus and minus two seconds. Regular Products—Optical amplifying gages; Toolmaker microscopes.

For more information circle **424** on inquiry card.

PACIFIC AUTOMATION PRODUCTS, INC., Glendale 1, California 919
Exhibiting: New Products—Cable Systems and Components

For more information circle **425** on inquiry card.

PANDUIT CO., Midlothian, Illinois 247
Exhibiting: New Products—Wiring Tube, spirally cut, non-flammable cable lacing; Cable Former, forms neat, compact cable; Electronic Wiring Duct; Stack Lugs, pressure connector allows numerous wires to be connected to one terminal. Regular Product—Wiring Duct.

For more information circle **426** on inquiry card.

PANELLIT, INC., Skokie, Illinois 718-720-817-819
Exhibiting: New Products—Panalarm Recording Annunciator, printout identification of selected conditions going off and returning to normal, plus visual/audible signals; Panalog 607 Information System, dual function combining logger and high speed continuous scanner, recorded measurements grouped by processing units, scans all variables recording off-normal values, audible signals. Regular Products—Panalarm annunciators, visual sequence, static magnetic and standard annunciator line.

For more information circle **427** on inquiry card.

PAR METAL PRODUCTS CORPORATION, Long Island City, New York 527, 529
Exhibiting: New Products Sliding chassis shelves, desks, drawers, turntable, platforms for inserting in standard relay racks. Regular Products—Enclosed and channel type relay racks, interior chassis supports, shelves, panels, etc.

For more information circle **428** on inquiry card.

PEERLESS ELECTRIC PRODUCTS DIV. ALTEC LANSING CORP., Los Angeles, Calif. 813, 815
Exhibiting: New Products—HV Power Supplies. Regular Products—Transformers.

For more information circle **429** on inquiry card.

PIC DESIGN CORP., SUB. BENRUS WATCH CO. East Rockaway, New York 219
Exhibiting: New Products—No Mar Set Screws; Precision Cluster Gear and Hub; Precision Internal Gears; Zero Adjustable Coupling; Regular Products—Precision tools, jig legs, studs, heel pins, hex nuts, washers, etc.; Precision shafting, spacers, ball bearings, spur gears; Precision 1, 2, 3 dial hubs, engraved disc dials, miter and level gears, shaft hangers, couplings; Speed reducers and differentials

For more information circle **430** on inquiry card.

POST MACHINERY CO., Electronic Products, Beverly, Mass. 444
Exhibiting: New Products—Model "SD-IT" Electronic Decade Counter for medium to fast speed operations. Regular Products—Decitron electronic counters.

For more information circle **431** on inquiry card.

POTTER AERONAUTICAL CORP., Union, New Jersey 222-224
Exhibiting: New Products—Model D11 Differential Flow Rate System, meters liquids with range of 100 to 1, down to zero flow. Model 35 Bill Printing Totalizer provides printed bill and visual indication of amount delivered, resettable, accumulative flow metered; Mass Gas Flowmeter, samples temperature and pressure of gas. Regular Products—Predetermined counter, electronic counter, specific gravity sensor, frequency converter, flow sensing elements, flow metering systems, ratiometer, tachometer frequency generators, Airborne flowmeter system.

For more information circle **432** on inquiry card.

POTTER INSTRUMENT COMPANY, Plainview, L. I., New York 536-538
Exhibiting: New Products—High-speed Transistorized Printer; Transistorized Digital Tape Handler. Regular Products—Paper tape reader, counters, tape handler.

For more information circle **433** on inquiry card.

PRODUCTION INSTRUMENT CO. (See General Controls Co.) 748

For more information circle **434** on inquiry card.

Two Executive Conferences — Human Factors in Systems Engineering

Manhattan College, New York, is co-sponsor of this Conference with the Fourth International Automation Exposition & Congress. Comprising eight sessions, this two-day Conference will take place in the Theatre of the Barbizon-Plaza Hotel, June 10 and 11, 1958.

Planned particularly for industrial and military executives with responsibility for the design, operation, and maintenance of man-machine systems of varying complexity, the purpose of the conference is to bring to participants a full understanding of the need for human factors consideration . . . the penalties implicit in ignoring these needs . . . and the specific techniques for matching machine and human specifications in systems design.

Plant Layout for Automation

Jointly sponsored by the Fourth International Automation Exposition & Congress and the Plant Layout Technical Workshop of Oakmont, Pa., this two-day conference will take place in the Theatre of the Barbizon-Plaza Hotel, June 12 and 13, 1958.

The Conference will be of particular value to executive and supervisory personnel who now face, or who are being groomed for, major production and plant management responsibilities.

Complete and intensive, the course will equip the participant with the newest data available in the field of plant layout. Coupled with a "do-it-yourself workshop," the course enables participants to relate techniques and values to their own jobs in their own plants.

Conference registration fee of $75 includes two luncheons and the Conference Proceedings. Early advance registration is urged.

For complete details, request Plant Layout Brochure or Human Engineering from Richard Rimbach Associates, Show Mgmt., 845 Ridge Avenue, Pittsburgh 12, Pa. Telephone FAirfax 1-9831.

QUARIE CONTROLLERS, Canton, Mass. 325
Exhibiting: New Products—Process Characteristic Analyzer, scans output of a unit process with respect to five process inputs; Universal Servo Input Adapter, reference voltage and dial end point controls reading directly in millivolts. Regular Products—Optimal controller.

For more information circle **435** on inquiry card.

REEVES SOUNDCRAFT CORP., New York 22, New York 947
Exhibiting: New Products—"Grimaco", grindable magnetic dispersion for use on magnetic drums and discs: "Magna-See", solution to make magnetic recordings visible. Regular Products—Magnetic recording tapes—type A data processing, type B telemetering, Professional audio application, magnetic films

For more information circle **436** on inquiry card.

REVCO, INC., Minneapolis 5, Minnesota 820
Exhibiting: New Products—Zero-Max Model 54, heavy duty infinitely variable speed reducer; Model M54, motorized variable speed reducer producing constant torque of 60 lbs. in.; Model M24 motorized variable speed reducer producing constant torque of 100 lbs. in. Regular Products—Zero-Max infinitely variable speed control units.

For more information circle **437** on inquiry card.

ROYAL MCBEE CORP., Port Chester, N. Y. 550-552-649-651
Exhibiting: New Products—Royal Precision LGP-30, single-address, fixed point, binary, stored program automatic electronic computer.

For more information circle **438** on inquiry card.

RUST INDUSTRIAL CO., Manchester, N. H. 225
Exhibiting: New Products—Miniaturized Strip Chart Recorder. Regular Products—Broadcast remote control equipment.

For more information circle **439** on inquiry card.

SANDERS ASSOCIATES, INC., Nashua, N. H. 532-543
Exhibiting: New Products—Electronic, Electro-Mechanical And Electro-Hydraulic Systems and Components

For more information circle **440** on inquiry card.

SCAM INSTRUMENT CO., Chicago, Ill. 426-428-430-432-434
Exhibiting: New Products—Annunciator Systems, for monitoring temperatures, pressures, and other possible abnormalities in industry. Regular Products—Annunciator alarm systems.

For more information circle **441** on inquiry card.

SENECA FALLS MACHINE CO., Seneca Falls, N. Y. 813, 815
Exhibiting: Power Amplifier; Displacement Transducer; Electronic Amplifier for automatic machine tool control.

For more information circle **443** on inquiry card.

SERVO SYSTEMS CO., Belleville 9, New Jersey 931
Exhibiting: New Products—SA103 Servo Controller, 60, 400, and to 2000 CPS; PS45VF Variable Frequency Supply, 300 to 2000 CPS. Regular Products—Servo-Kit; Servo-Speed/Torque Unit; Systems components.

For more information circle **444** on inquiry card.

EXHIBITORS and PRODUCTS

SOLA ELECTRIC CO., Chicago 50, Illinois **825**
Exhibiting: New Products—Constant Voltage Transformers; Regulated Electronic Power Transformers; Fixed and adjustable regulated DC Power Supplies; Adjustable Regulated AC & DC Voltage Supplies and related products
For more information circle **445** on inquiry card.

SOROBAN ENGINEERING, INC., Melbourne, Florida **924**
Exhibiting: Regular Products—Data Input-Output Systems including the following—high speed paper tape perforators, paper tape readers, coding keyboards, automatic tabulators, verifying and comparator equipment.
For more information circle **446** on inquiry card.

W. F. SPRENGNETHER INSTRUMENT CO., St. Louis 10, Mo. **446**
Exhibiting: Portable Blast and Vibration Seismograph; Seismological, geophysical, and engineering instruments.
For more information circle **447** on inquiry card.

STANDARD INSTRUMENT CORPORATION, New York 12, New York **627, 629**
Exhibiting: New Products—Tally-Count Electronic Batch Counter, momentary or lock-in closure of contacts at any predetermined count from 1 to 9999. Tally-Print Print-Out Counter, production totals at predetermined intervals on time-indexed strip chart. Regular Products—Time recorder-totalizer, electronic revs-switch, load switch, time totalizer.
For more information circle **448** on inquiry card.

STERLING PRECISION CORP., INSTRUMENT DIV., Port Washington, L. I., N. Y. **614**
Exhibiting: Standard Components—Miniature clutches, breadboards, gear heads, differentials, servo packages, etc.
For more information circle **442** on inquiry card.

TAURUS CORP., Lambertville, N. J. **448**
Exhibiting: Static Punched Card Sensor using standard IBM cards.
For more information circle **449** on inquiry card.

TELECOMPUTING CORP., Los Angeles, Calif. **813-815**
Exhibiting: New Products—High Temp. Ceramic Capacitors extremely small size. Regular Products—Micro-miniature relays.
For more information circle **450** on inquiry card.

THE TECHNICON COMPANY, Chauncey, New York **946**
Exhibiting: Technicon Autoanalyzer, perform complete chemical analysis automatically. Regular Products—Automatic Fraction Collector.
For more information circle **451** on inquiry card.

THER ELECTRIC & MACHINE WORKS, Chicago 6, Illinois **934**
Exhibiting: New Products—Automatically- regulated Semiconductor Rectifier Power Supply. Regular Products—Rectifiers, battery chargers.
For more information circle **452** on inquiry card.

THOMPSON-RAMO-WOOLDRIDGE PRODUCTS CO. Los Angeles 45, California **717-719**
Exhibiting: New Products—RW 3100 Digital Instrumentation and Data-Handling Systems, standard "building block" units utilizing solid-state components to construct systems to users' requirements. Regular Products—RW-300 Digital control computer
For more information circle **453** on inquiry card.

TOLEDO SCALE—DIV. TOLEDO SCALE CORP. Toledo, Ohio **321-323**
Exhibiting: New Products—Toledo Printweigh "400" weight records on tickets or sheets, or on remotely located office machines.
For more information circle **455** on inquiry card.

TRINCOR CORPORATION, Roselle Park, New Jersey **221**
Exhibiting: New Products—Moisture In Air Alarm; High Pressure Air Dryer, 5000 PSIG. Regular Products—Air Dryers, thermowells, thermocouple assemblies, compressor-dehydrators, compressed gas dryers.
For more information circle **456** on inquiry card.

TRINITY EQUIPMENT CORP., Cortland, N. Y. **221**
Exhibiting: New Products—High Pressure Heat-Les Dryer; Compressor-Dehydrator for Wave Guide and Cable Pressurization; Industrial Air and Gas Dryers. Regular Products—Dryers, thermowells.
For more information circle **457** on inquiry card.

TRU-SEAL DIV., FLICK-REEDY CORP. Melrose Park, Ill. **545, 547, 549, 551**
Exhibiting: Regular Products—Leakproof fittings for threaded connections
For more information circle **458** on inquiry card.

NOTICE

THIS IS A CALL FOR A MEETING TO EXAMINE THE NEED AND POSSIBILITY OF THE FORMATION OF A "SYSTEMS ENGINEERING COUNCIL."

All persons engaged or interested in systems engineering work, at any level, are invited to attend a meeting, which will be held at the Fourth International Automation Exposition, New York City Coliseum, June 10, 1958. 2:30 P.M., Room 415, Philippines Room.

EXHIBITOR CLINICS

Clinic classes will be held on four days—Tuesday, June 10 through Friday, June 13, 1958. Clinic hours are 9:30 to 11 am, 11:30 am to 1 pm.

Each clinic will comprise two to four identical lecture-demonstration sessions—one or two each day.

Pre-registration is required—fee is $1 per registrant per clinic session. Minimum fee is $2—For 2 sessions in one day.

COMPUTER CONTROL OF CHEMICAL PROCESS PLANTS—Thompson-Ramo-Wooldridge Products Co. Separate classes on:
- Computer control of oil refineries and chemical process plants.
- Automatic test control and data reduction
- Profit improvement via on-line control
- Test time savings via control and data reduction at the test site.

HIGH-SPEED ANALOG COMPUTERS—GPS Instrument Co., Inc.
- Features and advantages of high-speed computers vs real time computers. Typical applications.

THE ANALOG COMPUTER IN CONTROL SYSTEM DESIGN—Electronic Associates, Inc.
- The nature and capabilities of the analog computer
- Applying the analog computer to the design process
- Simulating a control system

LOGICAL DESIGN AND DIGITAL TECHNIQUES—Computer Control Company
- Design of digital systems using block technique
- The logical element and logic mathematics
- Untized logical elements

DIGITAL COMPUTER TECHNIQUES AND PRACTICE—Royal McBee Corporation
- Digital computer elements and operation
- Instruction and programming
- Typical applications
- Demonstration and discussion of the LGP-30

DIGITAL COMPUTER PRINCIPLES AND APPLICATIONS—Bendix Aviation
- Elements of the general purpose digital computer
- Instructions and programming
- Demonstrations and examination of the G-15 general purpose digital computer and accessories
- Intercom 1000—a system offering floating decimal point arithmetic with fixed or floating point input and output.

ANALYSIS AND OPTIMAL CONTROL OF CHEMICAL PROCESSES—Quarie Controllers
- Analysis of process characteristics—a disclosure of new techniques for analysis and optimal control.
- Types of characteristic curves for chemical processes
- The Quarie Controller for optimal control.

ANALOG COMPUTERS, FUNDAMENTALS AND APPLICATIONS—Mid-Century Instruments

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UNIVERSAL MATCH CORP., AVIONICS DEPT St. Louis 13, Mo. **744**
Exhibiting: New Products—Power Boost Unit, amplification 500:1, 20 lb. ft. at speeds up to 193 rpm, bi-directional control, unlimited angular rotation; Synchro Data Converter, Type 67A12, 2-channel servo converts angular position to d-c voltages for either telemeter or recorded applications. Regular Products—Actuators, miniature control amplifiers, automatic flight formation equipment systems and components, biological instrumentation, bomb hoist, chemical instrumentation, electrostatic clutches, distructors, flare dispensers, instantaneous and delayed explosive switches, navigation systems, photographic instrumentation, power control components, relays, servo systems, telemetering components, temperature monitors and controls.
For more information circle **459** on inquiry card.

U. S. GEAR CORPORATION, Wakefield, Mass. **526**
Exhibiting: New Products—Standard Ultraprecision Gearheads in planetary and spur types for use with BuOrd Servo-motor sizes 11 and 15. Fine Pitch Precision Stock Gears. Regular Products—Fine pitch precision custom gears to AGMA precision standards 1, 2, 3.
For more information circle **460** on inquiry card.

USSR CHAMBER OF COMMERCE **216, 218, 220, 317, 319**
Exhibiting: Automatic Instruments for Temperature, Flow, Level and other parameters of industrial Processes; Electronic Potentiometers, Electric Measuring Instruments, Regulators and Regulating Devices; Analytical Instruments; Apparatus and Automatic Devices for some Technological Processes in the manufacture of Instruments.
For more information circle **454** on inquiry card.

VANGUARD INSTRUMENT CORP., Valley Stream, New York **337**
Exhibiting: New Products—Voltage Regulator, "Building Block" form. Regular Products—Motion analyzers for photographic data reduction.
For more information circle **461** on inquiry card.

COMPU-TRONICS—National Cash Register Company
Disclosure of a new technique and new equipments

ELECTRONIC CIRCUITS VIA PLUG-IN MODULES—Engineered Electronics Co.
Features of modern plug-ins.
Developments of circuits with modules.
Symbolic logic circuits

AUTOMATIC PROGRAMMING AND TESTING VIA STATIC PUNCHED CARD SENSING—Taurus Corp. (Metron)
The static punched card sensor with 540 positions, a new approach to automatic programming and testing. Features and applications.

GAS ANALYSIS BY THERMAL CONDUCTIVITY—Gow-Mac Instrument Company
Principles of gas analysis by thermal conductivity
Chromatography
Typical applications and demonstrations

PLANT ECONOMICS WITH OPERATIONS RECORDERS—Gorrell & Gorrell
Use of recorders for analysis of plant operations
Economics of recording and analysis
Multi-point recording

WEIGHT, LOAD AND STRAIN CONTROL IN INDUSTRY—Baldwin-Lima-Hamilton Corp.
Principles and practice of SR-4 techniques
Applications in weight, load, torque, strain, etc.
Current status of SR-4 devices in automation

FLOW MEASUREMENT AND CONTROL WITH TURBINE FLOWMETERS—Potter Aeronautical
Principles of Pottermeter turbine-type flowmeters and related instrumentation
Typical applications in flow measurement and control
Calculation for mass flow, digital readout, etc.

PRESSURE CONTROL WITH PRESSURE SWITCHES—Gorn Electric Co., Aircraft Control Co. Div.
Principles and practice of pressure switches
Selection and application factors
Typical applications in aircraft and industry

STRUCTURAL PARTS FOR PRINTED CIRCUITRY—Gorn Electric Co., Electronics Div.
New concepts in printed circuit board packaging
Structural parts and connectors
Assembling actual circuits with "Gornets" and "Gornectors"

LEVEL AND FLOW CONTROL—McIntosh Equipment Corp.
Principles and applications of all types of on-off level and flow controllers

POTENTIOMETER RECORDERS—The Bristol Company
Principles of self-balancing recording
Applications in industry and research
High-speed self-balancing techniques

PHOTOGRAPHIC TECHNIQUES FOR AUTOMATION—Karl Heitz, Inc.
Survey of photographic techniques
Automatic techniques involving photography
High-speed photography

PRECISION ELECTRO-MECHANICAL COMPONENTS AND SERVOS—PIC Design Corp.
Precision instrument systems using electro-mechanical parts
Electro-mechanical servos
Use of stock parts for precision systems

SELECTIVE DATA PRINTERS—Copy-Craft, Inc.
Survey of need for selective data printers
Data printing techniques
The Ormig selective data printer
Typical applications in production control, accounting, etc.

PROCESS SCANNING AND LOGGING TECHNIQUES—Panellit Corp.
The integrated process control system with scanner-logger
New scanning and logging techniques
Typical applications
Built-in computing devices

MATHEMATICAL TOOLS FOR RAPID DATA ANALYSIS—Gerber Scientific Instrument Co.
Applications of the variable scale in engineering problems
Graphical-numerical computing devices and problems solvable on the GraphAnalogue—linear interpretations, frequency analysis, etc.
Obtaining derivatives of curves
Fitting equations to curves via the Equameter

CONTROL SERVO SYSTEMS—Waldorf Instrument Co.
Servo building blocks for digital indicators, integral servo driven analog indicators, analog-to-digital converters, etc.
The "Micromation" concept

ELECTRO-MECHANICAL COMPUTER ELEMENTS—Waldorf Instrument Co.
Miniature differentiators, integrators and vector solvers for typical analog computations

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Exhibiting: New Products—Count-Packs, high speed counters; Electric Preset Counter for ultra high speed counting. Regular Products—Mechanical and electro-mechanical counting devices.
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WALKER, CROSSWELLER & CO., Cheltenham, England 248
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Exhibiting: Floatless electrode type liquid level controls.
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ZENITH ELECTRIC CO., Chicago 10, Ill. 232
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ASME SESSIONS REGISTRATION

All members and guests must register for the 1958 Materials Handling Technical Sessions. The registration desk will be open from 9 a.m. to 9 p.m. from June 9th to June 13th. The registration card will admit you to all ASME Technical Sessions.

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These Sessions are scheduled during the Fourth International Automation Exposition. There is no registration fee for visiting the Exposition. It is required only that a registration badge be filled out and worn while attending the Exposition.

TECHNICAL SESSIONS

Honorary Chairman
Professor Carl F. Kayan
Columbia University, New York, New York

TECHNICAL SESSIONS. A very complete technical program has been scheduled (below). Early advance registration for the technical sessions is advised, as the capacity of the meeting rooms is limited. Registration fee is $1.00 per session. Here again immediate action will assure best results . . . send in your request and fee ($1.00 per session) NOW for registration in the Technical Sessions.

Tuesday, June 10

9:30 A.M. Session 1, Coliseum Canada Room, Second Mezzanine

THE CHALLENGE OF MEASUREMENTS

Chairman: DOUGLAS M. CONSIDINE, Director of Marketing, Hughes Aircraft Company, Products Division, Los Angeles, California

THE EFFECTIVE SELECTION OF MEASUREMENTS FOR PROCESS CONTROL

WILFRED H. HOWE, Chief Engineer, The Foxboro Company, Foxboro, Massachusetts

MORE EFFECTIVE METERING PRIMARIES FOR FLOW ACCOUNTING AND CONTROL

R. B. DOWDELL, Administrator, Research and Development, Builders-Providence, Inc., Providence, Rhode Island

A REALISTIC APPROACH TO ENVIRONMENTAL TEST MEASUREMENTS

BRUNO J. FORSHER, Member Technical Staff, Airborne Systems Division, Hughes Aircraft Company, Culver City, California

2:30 P.M. Session 2, Coliseum Canada Room, Second Mezzanine

DESIGN FOR AUTOMATION

Chairman: ROBERT CARSON, Managing Editor, Product Engineering, New York, New York

AUTOMATIC MANUFACTURE FOR HIGH PRODUCTION

CLIFFORD L. JOHNSON, Director of Production Engineering, AC Sparkplug Division, General Motors Corporation, Flint, Michigan

AUTOMATION CONQUERS AN ARDUOUS TASK

R. O. VUILLEUMIER, Technical Director, General Engineering Laboratories, American Machine & Foundry Company, Greenwich, Connecticut

AUTOMATING A LARGE LOW VOLUME PRODUCT

FRED BAUMANN, Manager of Advanced Engineering for the Small A-C Motor and Generator Department, General Electric Company, Schenectady, New York

2:30 P.M. Session 3, Coliseum United Nations Room, Second Floor

AUTOMATIC CONTROL VALVES

Chairman: E. ALBERT ADLER, Instrument Engineer, United Engineers & Constructors, Inc., Philadelphia, Pennsylvania

AUTOMATIC CONTROL VALVE PROBLEMS AND APPLICATIONS FOR POWER PLANT SERVICE

T. Y. MULLEN, Chief Mechanical Engineer, Power, Burns and Roe, Inc., New York, New York

ELECTROHYDRAULIC RELAYS IN CONTROL SYSTEMS

W. G. HOLZBOCK, Chief Engineer, Askania Regulator Company, Chicago, Illinois.

Third paper to be announced.

2:30 P.M. Session 4, Coliseum France Room, Second Mezzanine

MILITARY ELECTRONICS AND CONTROLS

Chairman: CDR CLAUDE O. MORRISON, USNR, Editor, Military Automation, Pittsburgh, Pennsylvania

DEVELOPMENT OF FULLY AUTOMATIC SHELL-FILLING MACHINERY

PHILIP ROSENBERG, Manager, Mechanics Research Department, American Machine and Foundry Company, Chicago, Illinois

AUTOMATIC CONTROL OF AIRCRAFT

C. R. BRYAN, Technical Director, Flight Control Laboratory, Wright Air Development Center, Wright-Patterson AFB, Ohio

AUTOMATION IN THE CONTROL OF SHIPBOARD SURFACE-TO-AIR MISSILES

ALOYSIUS KILGALLEN, Asst. Branch Head for Technical Matters, Research and Development Division, Bureau of Ordnance, Navy Department, Washington, D. C.

AUTOMATION OF COMMAND POST FACILITIES

RICHARD J. GALE, Chief, Data Systems Branch, Systems Engineering Division, U. S. Army Signal Corps' Engineering Laboratories, Fort Monmouth, New Jersey

Wednesday, June 11

9:30 A.M. Session 5, Coliseum Canada Room, Second Mezzanine

AUTOMATIC WEIGHING ON THE RUN

Chairman: A. T. GAUDREAU, Gau-Reau Associates, Westport, Connecticut

CONTINUOUS-FLOW WEIGHING

Speaker to be announced

AUTOMATIC WEIGHING WHILE CONVEYING

R. O. BRADLEY, Director of Engineering, Toledo Scale Company, Toledo, Ohio

WEIGHING CRANE PICK-UPS BY LOAD CELLS

ARTHUR C. RUGE, Ruge-DeForest Inc., Lima, Ohio

9:30 A.M. Session 6, Coliseum France Room, Second Mezzanine

MANUFACTURING AND AUTOMATION

Chairman: STEPHEN A. DERRY, Derry Engineers, Louisville, Kentucky

AUTOMATION BREAKDOWN

GEORGE H. AMBER, Amber & Amber, Detroit, Michigan

MAKING AUTOMATION WORK

EDWIN SUURONEN, Specialist, Automation Studies, Automation Task Force, General Electric Company, Utica, New York

MAKING FEASIBILITY STUDIES

E. RALPH SIMS, JR., Associate, Alden E. Stilson & Associates, Ltd.

MANAGING AN AUTOMATED PLANT OF THE FUTURE

RAYMOND VILLERS, Rautenstrauch and Villers, New York, New York

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2:30 P.M. Session 7, Coliseum Canada Room, Second Mezzanine

MEDICAL INSTRUMENTATION

Chairman: DR. RAYMOND JONNARD, Assistant Director, Laboratory, Prudential Insurance Company of America, Newark, New Jersey

PROBLEMS IN THE MEASUREMENT OF CARDIAC OUTPUT DURING ANESTHESIA

DUNCAN A. HOLADAY, Assistant Professor of Anesthesiology, Associate Attending Anesthetist, and LESTER C. MARK, Professor of Anesthesiology, Department of Anesthesiology, College of Physicians & Surgeons, Columbia University and Anesthesia Service, Presbyterian Hospital, New York, New York

Discussant: Dr. Henry O. Wheeler, Department of Medicine, College of Physicians and Surgeons, Columbia University and Presbyterian Hospital, New York, N. Y.

AUTOMATION IN THE CLINICAL LABORATORY

HENRY C. DICKERSON and GEORGE Z. WILLIAMS, Clinical Pathology Department, National Institute of Health, Bethesda, Maryland.

Discussant: Andres Ferrari, Technicon Company, Chauncey, New York

AUTOMATIC REDUCTION OF LABORATORY DATA

MURRAY EDEN, Laboratory of Technical Development, National Heart Institute, Bethesda, Maryland

Discussants: Mortimer Rogoff and Ronald Taplin, Federal Telecommunication Laboratories, Nutley, New Jersey, and Allyn W. Jones, Gawler-Knoop Company, Roseland, New Jersey

MINIATURIZATION OF EQUIPMENT FOR BIOLOGICAL AND MEDICAL RESEARCH

JONES BUSSER, American Electronic Laboratories, Philadelphia, Pennsylvania

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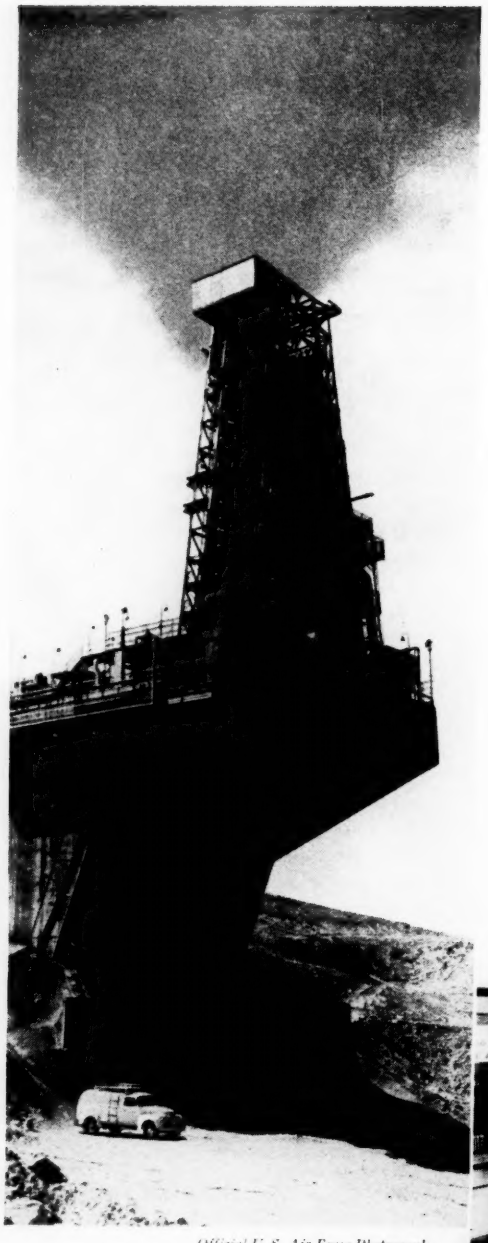

Official U. S. Air Force Photograph

When the stakes are high...

and the cost of failure is exorbitant, the peak of performance is required both from instruments and from men.

This is true of the scientists and engineers here at the Rocket Engine Test Laboratory, Edwards Air Force Base, California. Because they work with the Thor, Atlas and the secrecy-cloaked missiles of the future, they require instrumentation of unquestioned accuracy and dependability. To monitor thrust, flow, force and temperature parameters, they are using more than 600 Speedomax® G Recorders . . . part of one of the most extensive data recording systems in the United States.

Result: throughout more than five years of operation, Speedomax Recorders involved in data gathering have surpassed the exacting performance standards required by Edwards' instrument engineers.

LEEDS NORTHRUP
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Data from the 1-A (above) and 1-B (below) control rooms help Edwards' scientists evaluate missile performance.

"New Horizons", L&N's Tech. Pub. ND46 gives data on circuitry and performance characteristics of Speedomax instruments. Get a copy from your nearest L&N Office or from Leeds & Northrup Co., 4955 Stenton Ave., Phila. 44, Pa.

For more information circle **91** on inquiry card.

A guest editorial by *George Keinath*

editorial

Reflections On Fifty Years of Recording

WHEN I came to Siemens & Halske, Berlin, almost 50 years ago, to direct the new laboratory #3 (later there were 13 more), I was told that I should do "something about improving recorders" (of 1905 vintage). I have worked on recorders ever since that day. My most recent work is a survey of recording instruments and recording methods, which I prepared for the National Bureau of Standards and which will be published after passing the editorial committee at the NBS.

In 1905, chopper-bar instruments with arc ordinates were used for temperatures and for current, the latter with a recording interval of 2 seconds. About 1908, R. von Voss designed and built the first rectilinear current recorder with linear scale (ellipse-gear linkage) and ink recording. The linear ink recorder was adopted by many European instrument makers and is becoming increasingly popular in this country.

Also in 1908, the chopper-bar design was used for a continuous "high-speed" spark recorder, with the electric discharge going from the fixed curved bar through the thin recording paper to another bar under the chart. These sold for about 1400 Marks, while the rectilinear ink recorder was selling for only 400 Marks. Moreover, the ink recorder responded about twice as fast to changes in load as the "high-speed" spark recorder. When I told my boss that it was not fair to charge three times more for a bad recorder than for a good recorder I was told: "Never kill a cow as long as she gives milk." Nevertheless I went to work and after about one year I had a spark recorder, with rectangular, proportional ordinates and a response time of about 0.1 second. This instrument has been built for many years by Siemens & Halske.

The Siemens-Blondel mirror-type light-beam oscillograph with a natural frequency of about 6000 cps was in full production by 1910. During the first World War a high-speed paper development attachment, used in the field for gun location measurements, made the trace visible within 5 seconds after recording.

Another high-speed recording instrument was the moving-coil electrocardiograph, developed about 1915. This was more sensitive than the Einthoven string galvanometer: a small coil of platinum wire only 1/8 mil in diameter was wound with Wollaston wire and the silver etched away. This recorder had a natural frequency of 50 cps.

From about 1912 all Siemens recorders had rectilinear ordinates. Other companies used other means —curved paper or other linkages to do the same thing. It is surprising that until a few years ago not one American company had a rectilinear direct-acting ink recorder for power plant instrumentation. However, this country first introduced the motor-operated, high-sensitivity, potentiometer recorder on a large scale. To this day chopper-bar, direct-deflecting instruments still represent the greatest part of all European industrial temperature recorders.

In the mid-twenties Germany felt the American competition in potentiometer recorders, and tried, not entirely successfully, to develop a different motor-operated recording potentiometer. Much more successful was the a-c potentiometer (working without an amplifier) used to record dielectric losses and capacitance change versus voltage and versus time (in succession) to test the quality of insulation. This recorder, used to develop 400-kv multiturn current transformers, has great potential for testing. Discarding old rules about the maximum voltage between layers, instrument transformers for 220 kv had one-tenth the weight of their American counterparts.

Another interesting recorder was designed in 1918 by me. This was a facsimile picture transmission recorder used to transmit a crude sketch of a gun position from an airplane to the ground. Only one instrument was built and successfully tested when the 1918 armistice made it no longer interesting. The transmission time was about 5 minutes.

The Japanese developed the first 12,000-cps electromagnetic (galvanometer) oscillographic recorder system. Mr. Shin Aoki of Yokogama Denki Seisakusho Ltd. showed it to me in 1934.

X-Y Recorders

In my guest editorial of the January 1942 issue of *INSTRUMENTS*, I predicted the increasing importance and use of X-Y recorders, and introduced that term. Today at least one dozen manufacturers build them, although most are of a very expensive high-accuracy design which limits the great potential market. In my opinion an inexpensive medium-accuracy (1%) X-Y recorder (also usable for recording versus time) is as necessary for the test engineer as a slide rule.

Multichannel Problems

Chopper-bar recorders have been built for 50 years for six and even twelve temperatures, generally using different colors or patterns. This method, still used

almost exclusively, is unsatisfactory for more than 6 temperatures unless the traces do not overlap each other much. To use more recorders with fewer curves increases not only the initial cost but also the cost of panel space and servicing.

Miniature recorders help this problem a little. Whereas 10 or 20 years ago a 10″ chart was a standard width, today 3″ and even 2″ charts are considered acceptable for many applications. To save panel space, the depth of the smaller recorders behind the panel increased as much as 24″ for a 3″ chart. To save still more panel space, some recorders were banned to the basement or attic or mounted behind the panels!

In the same panel today there are found edgewise profile instruments, round instruments with 90° deflection, others with 300° deflection, small ones, big ones, disk-chart recorders and strip-chart recorders, all of different appearance because the instruments generally come from different instrument companies. Miniature profile instruments with scales only 3″ long save space, but do not help the supervision problem. Nobody can follow and remember the movements of 100 pointers; some sort of automation has to help the operator know when a dangerous condition is developing.

The necessity for supervision of a great number of variables—200 or even 500—with only one operator, has led to the development of monitoring, scanning and logging devices. Some only give an alarm when one variable is off the allowed limit; others use one indicator; still others start a recorder just for the abnormal transmitter, or for a small group, or for all variables (up to 270 in one of these designs). The recorders may trace scatter diagrams, or they may be digital loggers for one or many variables.

Despite many improvements the problem of supervising 100 to 200 variables or conditions in a process plant has not been solved to general satisfaction.

The memory device used should show the trend of the variable; this can be done only with an analog recording instrument. Scanning and signalling devices cannot show trends—the temperature of a bearing may be far below the permitted maximum, but its rate or rise may predict trouble within an hour.

But what can we do to keep an eye on 500 variables? Let us first look into the problems of accuracy, speed and presentation of the data.

Accuracy

Too many persons buy accuracy alone. Many buyers forget that a guarantee of 0.1% or 0.2% for the recording system does not mean that the accuracy will be the same under service conditions. The pickup element may not have this accuracy; thermocouples can introduce an error of 1 or 2%. In flight test recording, varying ambient and internal temperatures are encountered. It is not unusual for an engineer to give the accuracy of the counting-type flow measurement as 1 part in 10,000 because the maximum count is 10,000 although the flowmeter, at its best, has an accuracy of only 1 part in 100. For many recordings, an error of 2% or even 3% would not reduce the usefulness. However, high accuracy is needed for buying and selling energy and for special computing purposes.

Response Speed

"Speed" of the recorder usually is given by the time necessary for the pen or marker to cover the full range. For a multirecorder the switching time must be added. In general, the servo-type recorder cannot make more than one measurement per second unless the transmitters are so grouped that the pen need travel only a short distance. Thus a "high-speed" recorder can be very slow when used for a great number of variables.

If a digital logger is used, the logging cycle must be short for high accuracy. Yet a short logging cycle results in thousands of digits and a useless record. To prevent overheating of equipment, such as distribution cables, a slower, averaging, analog recording ammeter is more useful than a digital logger.

Presentation

The much quoted Chinese saying that one picture is better than 10,000 words can be varied to read that it is also better than 10,000 digits when it is desired to see immediately what is happening. Neither scatter diagrams nor digital loggers can offer the advantages of an analog trace for observation of trends. Although there are applications calling for each type of recorder, the simplest way to get trend data is by an analog trace. Thus it appears that in the long run multisegmental recorders will be used increasingly for the supervision of generating as well as production plants, supplemented with digital loggers where needed. Multi-segmental recorders alone offer many traces within reasonable areas.

Types of Segmental Recorders

There are two basic types of segmental recorders, one using conventional servomotor systems, the other the sweep-balance principle, which is simpler in electrical and mechanical design, more adaptable to special problems, allows high speed of recording, and whose parts move with constant speed.

The sweep-balance principle permits many modifications. Perhaps the most useful, and the least used today, has a constantly moving, vertical, endless-belt chart synchronized with the sweep generator and the balancing element; the time base moves from left to right across the chart. Traces of this type (with horizontal time base) are more easy to interpret than traces whose time base is vertical (that is, with vertical chart movement providing the time base along the chart).

Using sweep-balance technique, a recorder with a chart surface of 36″ height by 15″ width could provide 18 x 7 different recording areas of 2″ x 2″. If four traces of different color were used in each area,

a total of 18 x 7 x 4, or 504 variables could be plotted. This recording technique is covered in an article in this issue entitled "The Case for Sweep-Balance Recording."

New recording methods offer new possibilities. One of them is use of slave recorders. We may have a master recorder connected to 200 transmitters and tracing 200 small 2" x 2" diagrams in the office of the plant superintendent. At the same time a number of slave recorders are located where they are most needed and log the most important conditions (using conventional strip charts of any width and any chart speed). As slave recorders would have only a chart and drive and a marking mechanism, they would be inexpensive and take little space.

Appropriate measured variables would be connected to a digital logger where calculations of kwh, fuel consumption, efficiency, etc., are required.

The sweep-balance principle can serve the dual purpose of analog recording and simultaneous digital recording of selected variables. The same circuitry could be used to operate the chart marker and also send the digital signal to either a logger or computer. Here the end result would be both large number of analog traces for trend supervision, and direct digital readout as desired.

Systems Engineering Council News

THE big problem of Systems Engineering at this time is not in technical know-how, but in the ethics of client-professional-consultant relationships. We Systems Engineers have much to learn in this respect from the Architectural profession.

Architects sell only services, and the public appreciates what they can do. Architects have practically banished the bane of "free service" which is the biggest obstacle of Consulting Engineers in general, and Systems Engineers in particular.

The high stature of Architects is the result of years of team work and education. They now protect their hard won prestige by stern discipline of their own ranks.

Yes, we have much to learn from the Architects. As a starter, lets take what we can from their Standards of Professional Practice. The proposed "STANDARDS FOR THE PRACTICE OF SYSTEMS ENGINEERING" on pages 857-859 borrows heavily from AIA Doc. No. 330-A, Nov. 16, 1957.

Let us Systems Engineers openly acknowledge that we look to the architectural profession for leadership, and for the example of how to run our house.

George Amber
Amber & Amber

Process Characteristic Analysis

MUCH has been written about the exciting possibilities of computer control for optimum performance. But the single factor that has retarded the growth of the fields of systems engineering and computer control has been lack of knowledge about operating characteristics of the plant or process—the so-called *process characteristic*. Without such knowledge the engineer must operate only by empirical or theoretical methods, more often based on guess work than on fact. With knowledge of the process characteristic, however, all of the exciting implications of computer control for optimum performance become realizable.

INSTRUMENTS AND AUTOMATION is proud to reveal, via an exclusive disclosure, the first Process Characteristic Analyzer. If a fraction of what has been written about systems engineering and computer control is true, then the Process Characteristic Analyzer described in this issue is a revolutionary development.

The Process Characteristic Analyzer will be exhibited for the first time at the Fourth International Automation Exposition in New York, June 9-13, and 90-minute clinic classes, held on the dates of June 10-13 will teach registrants the specifics of application. Advance registration via the card on page 825 is urged upon all process engineers.

For the Record

THE efficiency of using an indicator as a means to recording emphasizes the low regard that an engineer or a scientist has for his own time. Today there is no excuse for technical workers making measurements by writing down indications and then plotting graphs. Such inefficiency in the face of the vast numbers of different types of automatic recorders is appalling. Nor can it be justified in the name of economy. Just as the efficiency of the industrial laborer of today can be measured in terms of the horsepower at his disposal, the efficiency of an engineer can be expressed in terms of the recorders at his disposal. An engineer who permits his management to use his services without giving him the proper tools is the equivalent of a mediocre laborer; a complete set of recorders can be said, today, to be an essential tool of every technical worker.

Two issues of *INSTRUMENTS AND AUTOMATION* are being devoted to the subject of recording. This issue (Part I) covers basic principles; Part (II), the August issue, will survey commercial recorders.

The purpose of these two issues of *INSTRUMENTS AND AUTOMATION* can be stated as (1) to show the basic principles and applications of available types of recorders and (2) to impress on engineering and scientific workers the economic necessity—to themselves and to their managements—for full use of recorders at every stage of technical work.

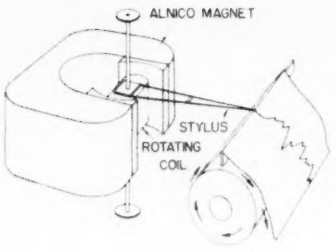


FIG. 1. DIRECT-WRITING galvanometer recorders use a moving coil in a magnetic field to power a stylus which records either by (1) ink pen on tip, (2) heating of heat-sensitive paper, (3) completing a circuit through electrosensitive paper, (4) scribing on blackened or pressure-sensitive paper or film, or (5) being pressed against paper by hammer or bar.

A B C

FIG. 2. TYPICAL DIRECT-WRITING GALVANOMETER RECORDERS. A shows Texas Instruments recorder with rectilinear recording, ¼-second full-scale pen speed, and sensitivity of 4.5 /ma; B shows Rustrak Model A of Rust Industrial, featuring chopper-bar recording, 1-ma full-scale deflection, 1-second response, and economy with price of less than $70; C shows Sanborn Model 358-100 recorder, featuring 8-channel

Introduction to Recorders

A survey of the basic features of the ten basic types of modern recorders.

MILTON H. ARONSON

THE TERM "recorder" refers herein to recorders of *electric* signals—recorders whose inputs are electric signals, usually expressed in terms of a voltage. As most process and test variables are today interpreted in terms of an electric signal, this is not a severe limitation of the "recorder field." Indeed, it will be seen that the number and types of such electric-signal-input recorders is so great that this minor limitation is necessary to a clear discussion of recorders.

Table 1—Basic Types of General-Purpose Recorders

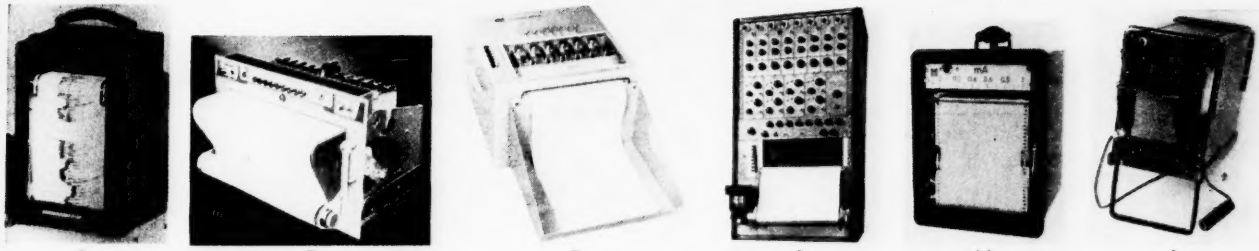
1. Galvanometer, direct recording
2. Galvanometer, light-beam recording
3. Galvanometer, chopper-bar recording
4. Galvanometer, light-beam servo-operated recorder
5. Null-balance potentiometer recording
6. Sweep-balance recording
7. Operations (events) recording
8. Receiver recording
9. Cathode-ray-tube plus camera recording
10. Multi-styli recording

Basic Types

Every technical worker should become familiar with the basic types of recorders listed in Table 1.

These ten basic types each have important subtypes. For example, the types of null-balance recorders include x-y recorders, x_1-x_2-y recorders, ratio or x/y recorders, line plotters, symbol plotters, digital x-y recorders, etc. The large number of types of recorders makes it essential that the principles, principal uses, and limitations of each type be thoroughly understood by every technical worker.

In view of the large number of basic principles, and the even larger number of available models of commercial recorders, it is necessary to approach the subject from two viewpoints—and in two issues. This issue discusses the basic principles and applications. A following issue (August) will survey the entire field of commercially available recorders.



D E F G H I

rectilinear recording with heated stylus, sensitivity of 10 uv/div; response to 100 cps; D shows Esterline-Angus recorder for ac, dc, power, etc., featuring 1-second response, sensitivity up to 50 ua full-scale; E shows Massa Labs 12-channel oscillograph with rectilinear ink or electric writing, and 200-cps response; F shows Edin recorder with either ink, electric or hot stylus, response to 350 cps; G shows Offner Electronics Dynograph recorder with sensitivity to 15 uv/mm with amplifier, response to 150 cps, zero drift, and choice of ink (curvilinear) or heat or electric (rectilinear) recording; H shows Curtiss-Wright ink or hot stylus recorder for ac/dc recording (made by Metrawatt A. G. of Germany); I shows Acton 550-A recorder which uses a scribe that traces on 35-mm film (blackened with carbon black), featuring response to 1000 cps.

Basic Recording Factors

The basic factors in selection and use of a recorder are:

1. Frequency response
2. Range (or span)
3. Accuracy
4. Presentation
5. Cost
6. Accessories, dimensions, and other operational factors

Galvanometer Recorders

As shown in Table I, there are four types of recorders that use galvanometers.

The heart of all galvanometer-type recorders is, obviously, the galvanometer. Although galvanometers are available for recording of frequencies up to 10,000 cps, frequency response is obtained at the expense of sensitivity. The factors that enter into proper use and selection of galvanometers are discussed in an article in this issue.

The basic advantages of galvanometers—economy, high sensitivity, and adaptability to a wide range of frequencies—have made them the most common recording means for signals in the frequency range below 1000 cps.

Wherever the signal is so small that it cannot operate the galvanometer directly, an amplifier is required. All technical workers again must be familiar not only with galvanometer factors but amplifier factors as well. Amplifiers will be also covered carefully in this series of articles on recorders.

Direct-Recording Galvanometer

In direct-recording galvanometer recorders the stylus or pen is attached to a coil in the field of a permanent magnet, as shown in Fig. 1.

The direct-writing recorders of the type shown in Fig. 2 use either (1) ink pen, (2) stylus tracing on carbon-coated film, (3) heated stylus and heat-sensitive paper, (4) metal stylus and electrosensitive paper, or (5) chopper bar that presses stylus against the paper, perhaps using a typewriter ribbon to make the impression.

The chopper-bar technique is the most economical technique, but is also the most limited in response. Available recorders using this technique are for signals of less than 1 cps.

Many ink recorders use curvilinear coordinates on the chart because the arc of the pen is a curve, not a straight line. Fig. 3 shows the difference between a curvilinear and a rectilinear recording of an a-c signal.

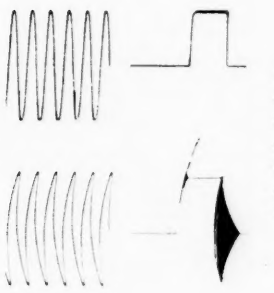


FIG. 3. DIFFERENCE between curvilinear and rectilinear recording of an a-c signal. Also shown are overshoot and ringing caused by inadequate damping.

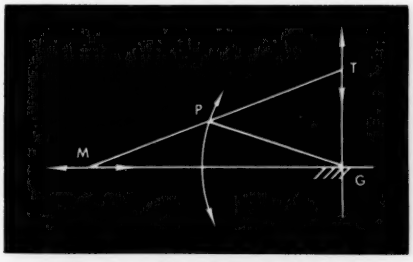


FIG. 4. TRANSLATION of curvilinear tip motion into rectilinear motion in the Texas Instruments "rectiriter." PG is galvanometer arm; MT is writing arm; T is tip of pen point.

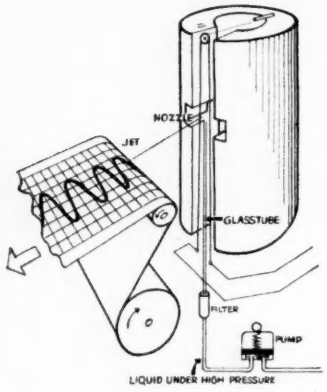


FIG. 5. MINGOGRAPH Elema jet recorder (Swedish) uses ink jet to obtain flat response to 500 cps.

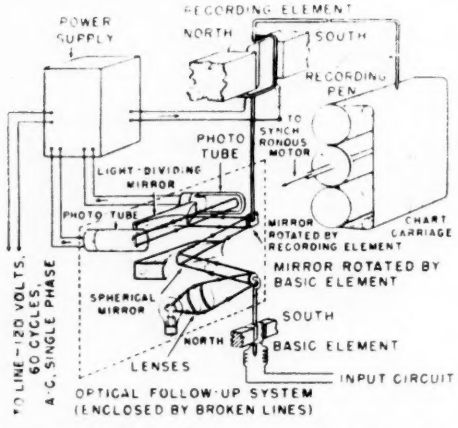


FIG. 6. PRINCIPLE of galvanometer light-beam servo-operated recorder. Upper mirror is made to follow motion of lower mirror (attached to galvanometer) by servo action. (Courtesy General Electric)

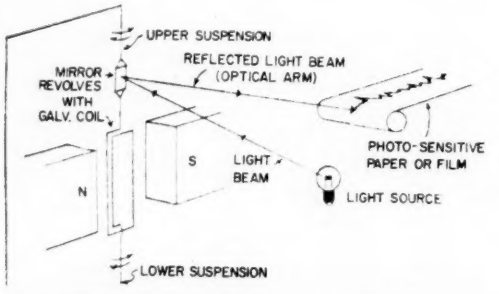
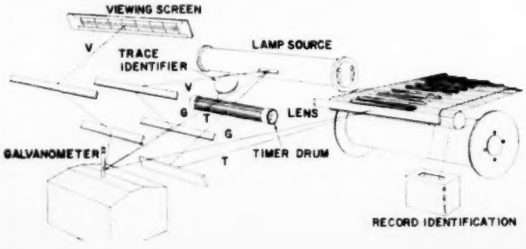


FIG. 7. PRINCIPLE of galvanometer light-beam recording.

FIG. 8. INDEPENDENT optical systems permit recording, viewing, timing, and trace identification. (Courtesy Midwestern Instruments)



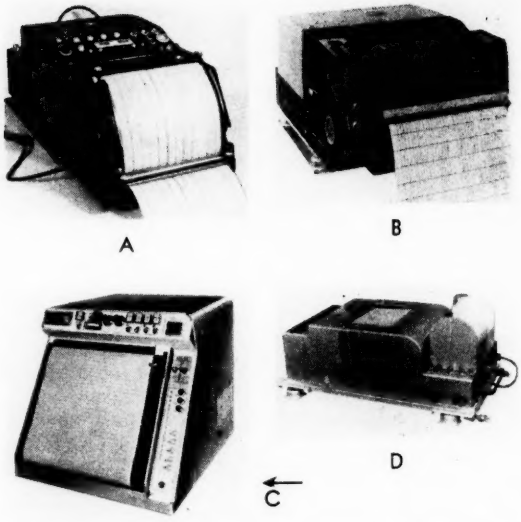


FIG. 9. TYPICAL GALVANOMETER LIGHT-BEAM RECORDERS. A shows Consolidated Electrodynamics 50-channel Model 5-119 with response to 3000 cps, and Datarite processor that processes paper at speed of 25"/sec while recording; B shows D/R Direct Recorder Model 602 of Midwestern Instruments, featuring 50 channels, writing speed above 30,000"/sec, and direct readout without chemicals; C shows Hell-and Visicorder Model 1012, featuring 36 channels, response to 3000 cps, and direct readout without chemicals; D shows Century Electrograph Model 422 with 24 channels, using electrophotosensitive (Electrofax) paper for rapid readout.

Although heated-stylus and electrosensitive recorders are usually rectilinear recording, and ink pens usually curvilinear, recorders are now available in which the curvilinear pen motion is changed into rectilinear motion by mechanical means. Fig. 4 shows one way in which this is done.

Fig. 5 shows the principle of the jet recorder.

Fig. 6 shows the principle of the galvanometer light-beam servo recorder, which uses a galvanometer but whose light beam operates a servomechanism to make the trace.

The cost of direct-recording galvanometer recorders ranges from less than $70 to more than $3000 (for a multi-channel unit complete with amplifiers).

Galvanometer Light-Beam Recorders

Fig. 7 shows the principle of galvanometer light-beam recording. As the galvanometer moves only the tiny mass of a mirror, the frequency response is increased from the 1000-cps upper response figure of direct-recording types to about 5000 cps, which is near the practical limit of light-beam recording types. The beam "writes" on photosensitive film or paper.

In light-beam recording, both rapid wet and dry processing techniques without chemicals now give almost immediate readout, eliminating the once inherent disadvantage of this technique—developing time.

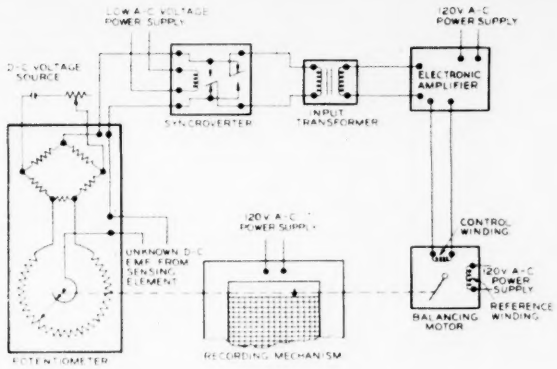


FIG. 10. CHOPPER-TYPE technique is most common potentiometer principle. (Courtesy the Bristol Co.)

As shown in Fig. 8, independent optical systems for recording, viewing, and timing offer high flexibility, and as many as 50 channels can be used with one instrument.

Fig. 9 shows typical galvanometer light-beam recorders. Costs range from $2000 to $10,000.

Potentiometer Recorders

Null-balance recorders are servo-operated devices that are generally referred to as potentiometers (Fig. 10). The basic advantages of the null-balance potentiometer are (1) high sensitivity, down to microvolt signals, and (2) independence of lead length. The sensitivity is realized by the inherent amplification in the servo system; independence of lead length is realized by cancelling out the input signal so that no signal flows at balance.

These two basic advantages are gained at the expense of response speed; potentiometers cannot operate at speeds faster than about ¼ second full-scale pen travel, limiting the response to signals of less than 1 cps. However, at these frequencies the potentiometer principle opens up vast areas for recording.

Fig. 11 shows typical potentiometer recorders.

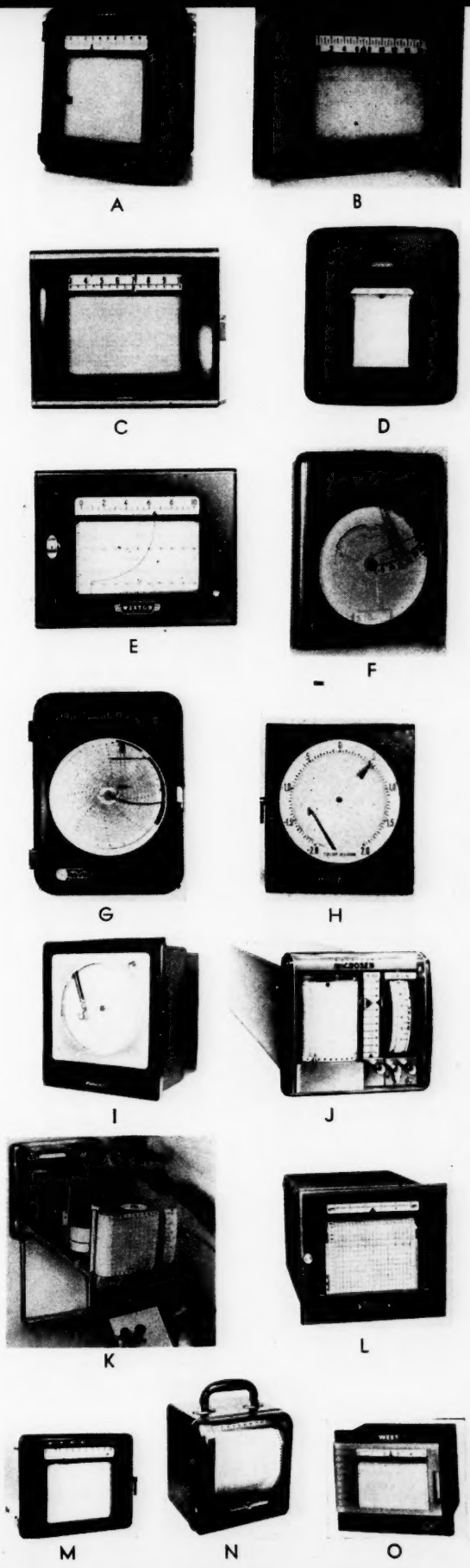


FIG. 11. TYPICAL POTENTIOMETER recorders. A shows Leeds & Northrup Speedomax Type with 0.4-second full-scale pen travel and 0.1 mv range as voltmeter; B shows Honeywell Electronik with ¼-second full-scale pen travel; C shows Bristol Dynamaster potentiometer with 0.4-second pen travel; D shows Foxboro Dynalog recorder with 1-second pen travel; E shows Daystrom-Weston Potentiometer Series 6700 with 1-second pen travel; F shows Bailey Meter potentiometer recorder Class E with 1-second pen travel; G shows the Hagan Powrlog Electronic Recorder, a potentiometer recorder with 2-second pen travel; H shows the General Electric potentiometer with magnetic standard; I shows the Fielden potentiometer recorder; J shows the Microsen recorder of Manning, Maxwell & Moore, based on the Microsen balance; K shows the Autronic recorder of Swartwout; L shows the Westronics compact recorder; M is the Wheelco 8000 Series recorder; N is the Varian potentiometer recorder; O is the West Instrument "tubeless" recorder.

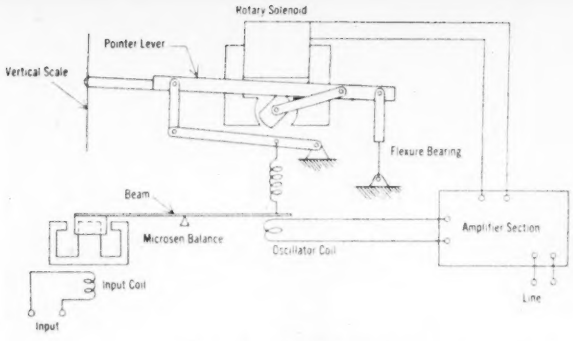


FIG. 12. **MICROSEN** balance principle.

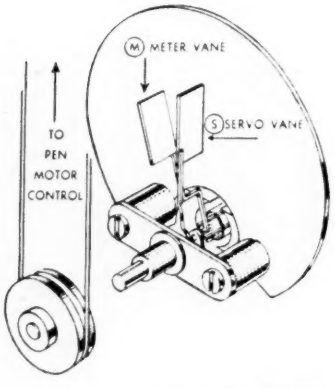


FIG. 13. **FIELDEN** Tektolog principle.

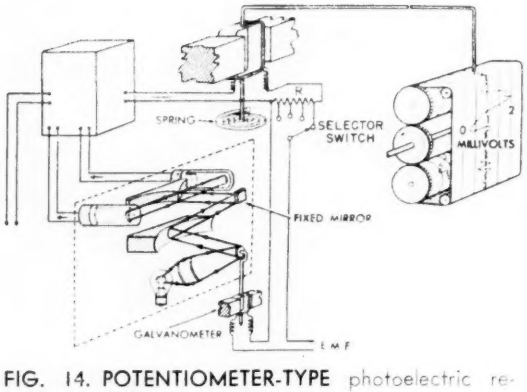


FIG. 14. **POTENTIOMETER-TYPE** photoelectric recorder of GE.

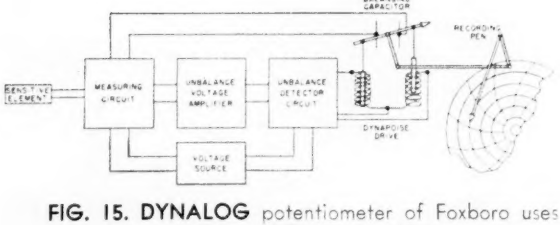


FIG. 15. **DYNALOG** potentiometer of Foxboro uses balancing capacitor and Dynapoise drive.

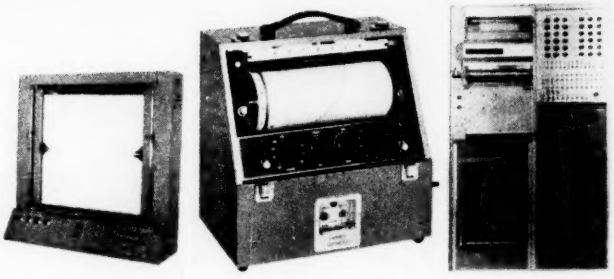


FIG. 16. **TYPICAL X-Y RECORDERS.** A shows Electronic Associates Model 99.109, which can plot either lines or points; B shows Moseley Model 1; C shows the

Nearly all process and test variables can be measured in terms of minute electric signals, and often must be measured at distances from the point of recording. Further, the potentiometer, which is basically an emf-measuring device, can be used with minor modifications as a null-balancing bridge-input recorder, which is basically a resistance (or inductance or capacitance) measuring device. Hence this instrument is a general-purpose, flexible, sensitive instrument for measurement of emf, resistance, capacitance, or inductance.

Various techniques are used in servo-balanced potentiometers, although the most common is the type shown in Fig. 10, using a "chopper" to convert the d-c signal into an a-c signal for amplification.

Fig. 12 shows the Microsen balance principle of the Manning, Maxwell & Moore Co., in which the input signal moves a beam, changing the current in an oscillating circuit, which change is used to reposition the beam.

Fig. 13 shows the Fielden Tektolog principle using a vane on a galvanometer, which acts as one plate of capacitor in a bridge circuit, which is then rebalanced.

Fig. 14 shows the principle of the potentiometer-type photoelectric recorder of GE.

Fig. 15 shows the Foxboro Dynalog principle.

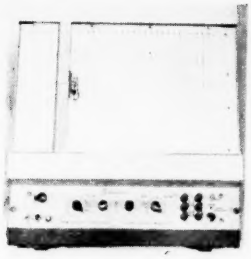
Still another advantage of the servo principle is that unlimited power is available to drive auxiliary control devices. The potentiometer is thus the heart of many modern control systems.

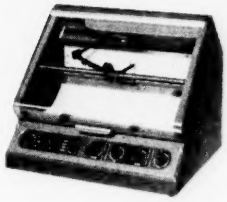
The price range of potentiometer recorders is from $350 to $800 (1 channel).

x-y Recorders

A further advantage of the servo principle is that it can be used to move the chart or y scale in the same way that the signal moves the recorder element (x axis). This leads to the x-y recorder, the x_1-x_2-y recorder, etc. Today one can plot curves, lines, or even a detailed engineering drawing of a house or bridge by feeding digital data to an x-y recorder. The x-y recording principle permits rapid recording of tube characteristics, valve characteristics, filter characteristics, etc., etc. Fig. 16 shows typical x-y recorders.

Prices of x-y recorders range from $1000 to more than $20,000.





D E

Talley Realiter Visual Recorder Model 314, which can plot 12 variables at 50 points per second from binary input data; D shows Electro Instruments Model 225; E shows Librascope x-y recorder.

Sweep-Balance Recorders

The sweep-balance technique (Fig. 17) refers to the marking of a chart at the instant that the signal equals the amplitude of a sweep (ramp) signal. This technique is not yet widely used in this country, but has some of the sensitivity of potentiometer recording plus high-speed response. The response becomes essential for multichannel recording, as is discussed in an article in this issue.

Receiver Recorders

Receiver recorders are recorders designed to receive the output only from a remote transmitter, usually a synchro or a differential transformer.

Operations Recorders

Operations recorders are on-off "events" recorders, signifying only that a variable was in one of two (or three) possible states at a given time. These are used primarily for monitoring purposes, but have the advantage that hundreds of "channels" can be monitored for long periods of time.

The revolving-drum-type recorder is commonly called a *kymograph*. Styli, magnetic markers or pneumatic marking devices can be used. Strip-chart multi-styli recorders are also known as *polygraphs*.

Cathode-Ray-Tube Plus Camera

The oscilloscope plus camera is the technique that is most common above 5000 cps.

Multiple Styli

Recorders are available with a battery of fixed styli which can be energized by pulsed or digital data. These have been operated from magnetic tape to record signals above 24 kc.

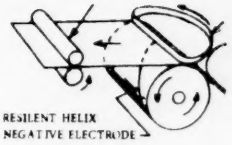
Accessories and other Factors

As wonderful and flexible as the many types of recorders available are the accessories and features that are offered with them.

Amplifier types include dc, carrier, d-c differential, servo-balanced, a-c, and others.

Polar coordinate converters are available to convert polar to x-y signals.

Pen vibrators of adjustable frequency and amplitude overcome effect of friction in servo-balanced systems.



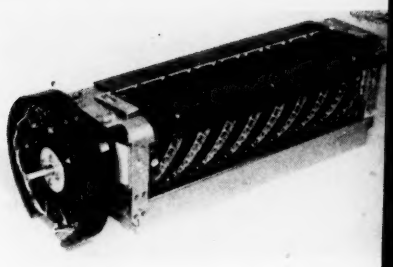


FIG. 17. SWEEP-BALANCE, or "flying spot" technique of Alden uses a helix on a drum, which contacts the chart at a point that sweeps across the chart as the drum rotates. Multiple helixes permit multichannel recording.

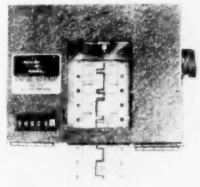


FIG. 18. TYPICAL OPERATIONS recorder of Standard Instrument Corporation records and totalizes on-off times of machinery, etc.

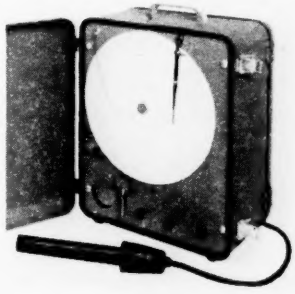


FIG. 19. ELECTROLYTIC CONDUCTIVITY recorder type RQ of Industrial Instruments.

Response characteristic can be altered from linear to logarithmic or quasi-logarithmic.

Chart speeds can be selected by push button.

Galvanometers can be damped by velocity feedback or acoustic damping.

Charts can be a-c, d-c, spring, or pneumatic driven.

Chart papers can be printed to specifications.

Vacuum-paper holddown prevents chart slippage.

Charts have unused chart footage indicators.

Lights indicate when chart is moving at synchronous speeds.

Pens have 1-yr capillary ink supply, etc.

Auxiliary printing devices can print on charts.

Special Recorders

All the recorder types described are general-purpose, demanding only an electric signal input. In addition to these general-purpose instruments, there is a large number of special-purpose recorders. For example, Fig. 19 shows an electrolytic conductivity recorder. Other special recorders are available for welding analysis and other special purposes. These, plus *all* commercially available recorders, will be surveyed in the August issue of *I&A*.

American Standard Specifications for Automatic Null-Balancing Electrical Measuring Instruments

This standard is the result of the efforts of Sectional Committee C39 on Electrical Measuring Instruments and its subcommittees and is a further extension toward the goal of a complete set of American Standards on electrical measuring instruments intended to assure that instruments conforming to them will be satisfactory for general industrial use. Suggestions for improvement gained through experience in the use of this standard will be welcomed. They should be sent to the American Standards Association, Incorporated, 70 East Forty-fifth Street, New York 17, N. Y.

Definitions

THE definitions in this section apply to automatic null-balancing electrical measuring instruments within the scope of this American Standard. For additional definitions, see American Standard Definitions of Electrical Terms, C42.30-1957, or the latest revision thereof approved by the American Standards Association, Incorporated.

4.1 ACCURACY. (See 4.10, Error and Correction.)

4.2 ACCURACY RATING. The accuracy rating of the instrument is the limit which errors will not exceed when the instrument is used under any combination of rated operating conditions. It is expressed as a percent of the span or as a fixed value in the units of the measured quantity. The accuracy rating does not include primary detectors or intermediate means external to the instrument. (See 4.10, Error and Correction.)

4.3 CORRECTION. (See 4.10, Error and Correction.)

4.4 DAMPING CHARACTERISTIC. The damping characteristic of an instrument is a criterion of the dynamic performance when approaching a balanced condition. It is the maximum overshoot (if any) beyond the point of final rest, expressed in percent of span.

4.5 DEAD BAND. Dead band is the range through which the measured quantity can be varied without initiating response. This is usually expressed in percent of span.

NOTE: *Threshold and Ultimate Sensitivity* are defined as one-half the dead band. When the instrument is balanced at the center of the dead band, they denote the minimum change in measured quantity required to initiate response. Since this condition of balance is not normally achieved and is not readily recognizable, these terms are not used in this standard and the various requirements are stated in terms of dead band.

Sensitivity is frequently used to denote the same quantity. However, its usage in this sense is deprecated since it is not in accord with accepted standard definitions of the term.

4.6 DEAD BAND RATING. The dead band rating is the limit which the dead band will not exceed when the instrument is used under rated operating conditions.

4.7 DESIGN RATINGS. Design ratings are evaluations of certain design aspects of the instrument in terms of certain limiting conditions to which the instrument may be subjected without permanent physical damage or impairment of operating characteristics.

4.8 DYNAMIC RESPONSE. Dynamic response is the behavior of the instrument output as a function of the measured quantity, both with respect to time. (See 4.4, Damping Characteristic; 4.8.1, Step Response; 4.8.4, Frequency Response; and 4.8.6, Ramp Response.)

4.8.1 STEP RESPONSE. Step response is a criterion of the dynamic response of an instrument when subjected to an instantaneous change in measured quantity from one value to another.

4.8.2 STEP RESPONSE TIME. Step response time is the time required for the end device to come to rest in its new position after an abrupt change to a new constant value has occurred in the measured quantity.

4.8.3 SPAN STEP-RESPONSE-TIME RATING. The span step-response-time rating is the limit which the step response time will not exceed for a change in measured quantity, essentially equivalent to full span when the instrument is used under rated operating conditions. The actual span step response time shall not be less than 2/3 of the span step-response-time rating. (For example, for an instrument of 3-second span step-response-time rating, the span step response time, under rated operating conditions, will be between 3 and 2 seconds.)

It must be recognized that the step response time for smaller steps is not proportional to the span response time for full span.

NOTE: The end device shall be considered to be at rest when it remains within a band of plus and minus the accuracy rating from its final position.

4.8.4 FREQUENCY RESPONSE. Frequency response is a criterion of the dynamic response of an instrument when the measured quantity is varied sinusoidally over a band of frequencies. It is usually expressed as the output-to-input amplitude ratio versus frequency and the phase shift between output and input versus frequency.

4.8.5 SPAN FREQUENCY-RESPONSE RATING. The span frequency-response rating is the maximum frequency in cycles per minute of sinusoidal variation of measured quantity for which the difference in amplitude between output and input represents an error no greater than five times the accuracy rating when the instrument is used under rated operating conditions. The peak-to-peak amplitude of the sinusoidal variation of measured quantity shall be equivalent to full span of the instrument.

It must be recognized that the span frequency-response rating is a measure of dynamic behavior under the most adverse conditions of measured quantity (i.e., the maximum sinusoidal excursion of the measured quantity). The frequency response for an amplitude of measured quantity less than full span is not proportional to the frequency response for full span.

The relationship between the frequency response of different instruments at any particular amplitude of measured quantity is not indicative of the relationship that will exist at any other amplitude.

4.8.6 RAMP RESPONSE. Ramp response is a criterion of the dynamic response of an instrument when subjected to a measured quantity which varies at a constant rate.

4.8.7 RAMP RESPONSE TIME. The ramp response time is the time lag, expressed in seconds, between the measured quantity and the equivalent positioning of the end device, when the measured quantity is varying at constant rate.

4.8.8 RAMP RESPONSE-TIME RATING. The ramp response-time rating is the maximum ramp response time for all rates of change of measured quantity not exceeding the average velocity corresponding to the span step-response-time rating of the instrument when the instrument is used under rated operating conditions. Example: If the span step-response-time rating is four seconds, the ramp response-time rating shall apply to any rate of change of measured quantity not exceeding 25 percent of span per second.

4.10 ERROR AND CORRECTION. The error of indication expresses the accuracy of the instrument and is the difference between the indication and the true value of the measured quantity. It is the quantity which algebraically subtracted from the indication gives the true value. A positive error denotes that the indication of the instrument is greater than the true value. The correction has the same numerical value as the error of indication, but the opposite sign. It is the quantity which algebraically added to the indication gives the true value.

Error = Indication—True
Correction = True—Indication

4.18 MEASURAND. The measurand is a physical quantity, property, or condition which is to be measured.

4.20 NULL BALANCE. As applied to instruments within the scope of this American Standard, null balance is the condition which exists in the circuits of an instrument when the difference between an opposing electrical quantity within the instrument and the measured quantity does not exceed the dead band. The value of the opposing electrical quantity produced within the instrument is related to the position of the end device.

4.22 PERFORMANCE RATINGS. Performance ratings are the limits of the values of certain operating characteristics of the instrument which will not be exceeded under any combination of rated operating conditions.

4.23 POSITION INFLUENCE. Position influence is the change in the indicated or recorded value caused by mounting the instrument with its vertical axis inclined from normal by a specified angle.

4.26 RANGE. The range of an instrument is the region covered by the span and is expressed by stating the two end-scale values. If the span passes through zero, the range is stated by inserting "zero" or "0" between the end-scale values. (See 4.33, Suppressed Zero Range.)

4.26.1 SCALE RANGE. Scale range is the range expressed in scale units.

4.26.2 ELECTRICAL RANGE. Electrical range is the range expressed in equivalent electrical units.

4.27 RATED OPERATING CONDITIONS. Rated operating conditions denote the limits of specified variables or conditions within which the performance ratings apply. (See 4.12, Extreme Operating Conditions.)

4.28 REPRODUCIBILITY. Reproducibility is the ability of the instrument to produce consistently the same position of the end device for the same value of the measured quantity under the same conditions of operation.

4.31 SPAN. The span of an instrument is the algebraic difference between its end-scale values.

4.31.1 SCALE SPAN. Scale span is the span expressed in scale units.

4.31.2 ELECTRICAL SPAN. Electrical span is the span expressed in equivalent electrical units. It is the change in the measured quantity to cause the end device to travel between scale limits.

4.33 SUPPRESSED ZERO RANGE. A suppressed zero range is an instrument range which does not include zero.

4.34 SUPPRESSION RATIO. The suppression ratio is expressed as the ratio of the electrical equivalent of the smaller end-scale value to the electrical span. (For example, the suppression ratio is 2 for a range of 20 to 30 millivolts or for a range of —30 to —20 millivolts.)

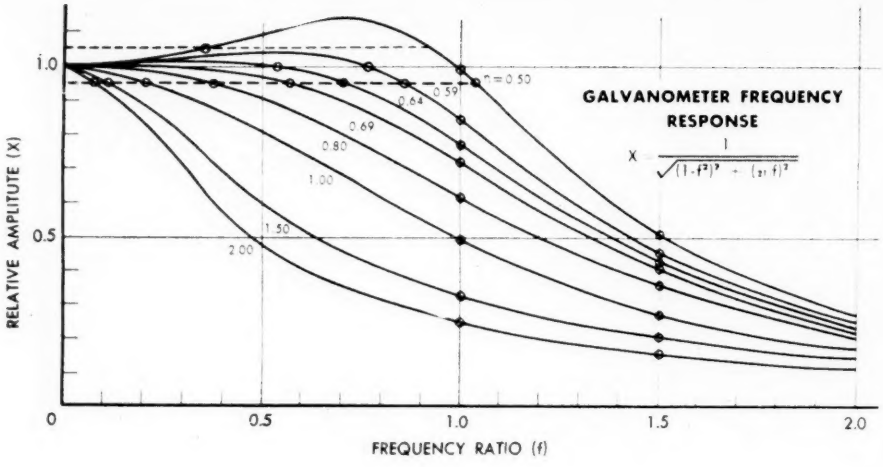


FIG. 1. FREQUENCY RESPONSE of galvanometer. Dotted lines bracket ± 5% response area.

Selecting a RECORDING

SELECTION of a galvanometer for a specific application is a compromise of five factors:

1. Frequency response
2. Sensitivity
3. Phase angle
4. Damping
5. Power dissipation

The first consideration is frequency response because the galvanometer should respond linearly to the signal. As high-frequency galvanometers have low sensitivity, a galvanometer with minimum adequate undamped natural frequency usually should be selected. For linear response the signal frequency should not exceed 60% of the galvanometer's natural frequency. Therefore, *select a galvanometer whose natural frequency is 1.6 times the highest frequency signal to be recorded.*

Damping

The 1.6 figure is selected because a galvanometer with optimum damping (64% of critical damping) will have flat frequency response (± 2%) from 0 to 60% of its natural frequency, as shown in Fig. 1. In order to achieve this, it is necessary that the galvanometer be damped to 64% of critical damping. This is considered optimum—that is, the best compromise between overshoot and time to come to final position.

With a damping factor of 64% of critical it is theoretically possible to have flat galvanometer response up to 60% of the natural frequency of the galvanometer.

For any given galvanometer the optimum damping resistance is specified. However, the resistance of the driving source (R_s) must be known because this resistance becomes a part of the resistance that the galvanometer "sees," as shown in Fig. 2.

In Fig. 2, R_g is the galvanometer coil resistance, R_d is the desired (specified) damping resistance to achieve optimum performance. In the ideal case the resistance of the source (R_s) would equal the desired damping resistance (R_d). But as this is seldom true, either a series resistance (R_a) or a parallel resistance (R_b) or both usually must be used to realize the desired response.

Note that the effective R_s is made up of R_s, R_a *and* R_b. Obviously, if the source impedance is greater than the desired damping resistance, a parallel damping resistor must be used; if the source resistance is smaller than the damping resistance, then a series resistor is used. The proper values for optimum damping in each case can be calculated from the following:

To find the series damping resistance when R_s is smaller than R_d:

$$R_a = R_d - R_s$$

To find the parallel damping resistance when the R_s is greater than R_d:

$$R_b = (R_s \times R_d) \div (R_s - R_d)$$

If both a series and parallel damping resistance is to be used:

$$R_b = (R_s + R_a) \times (R_d) \div (R_s + R_a - R_d)$$

This may be required when matching a galvanometer to an amplifier, where the proper loading for the amplifier must also be considered.

Selection factors include frequency response, sensitivity, phase angle, damping relationships, and power dissipation.

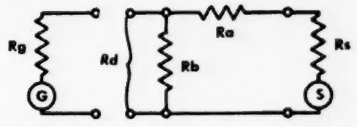


FIG. 2. RESISTANCE in a galvanometer circuit always includes source resistance (R_s) and galvanometer resistance (R_g), and may also include external series resistance (R_a) and external parallel resistance (R_b).

GALVANOMETER

LLOYD MOYER
Heiland Division
Minneapolis-Honeywell

Galvanometers can be used at damping ratios other than that specified (64%). If this is desirable, the sensitivity can be calculated from the equations given in the literature, and the frequency response and phase angle determined from Figs. 1 and 3.

Damping affects not only frequency response but also phase angle, step-function response, damping relationships and linearity.

Phase Relationship

In recording any complex waveform the waveform will not be distorted if the phase lag (angle due to damping) increases linearly with frequency. This is because with linear phase-shift the second harmonic will be shifted twice as many *degrees* as the fundamental, the third harmonic will be shifted three times as many degrees, etc. However, this means that all harmonics will experience the same time lag in *seconds* as the fundamental—and hence no distortion will result (up to about 1.2 times the natural frequency).

The curves in Fig. 3 represent the theoretical phase-angle between a sinusoidal voltage applied to the galvanometer coil and the coil deflection. To make the curves applicable to galvanometers of any undamped natural frequency, the frequency of the voltage is shown as the ratio of this frequency to the undamped natural frequency of the galvanometer. Phase-angle depends on the amount of damping (electromagnetic or fluid), and although the curves in Fig. 3 are plotted for several ratios of electromagnetic damping they can, for all practical purposes, be used for fluid-damped galvanometers. For any frequency ratio and amount of damping, the phase angle is shown directly.

Note that the most linear phase-angle response (least distortion) occurs at damping of 64% of critical, to which all electrodynamically- and fluid-damped galvanometers are adjusted by the manufacturer.

Damping Relationships

The theoretical relationship between the electrical resistance which damps the galvanometer coil and the corresponding damping ratio are illustrated in

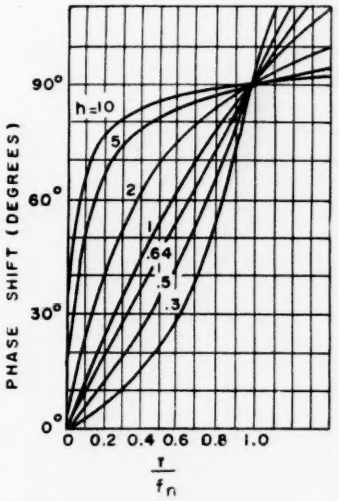


FIG. 3. PHASE RELATION between applied sinusoidal signal and galvanometer deflection.

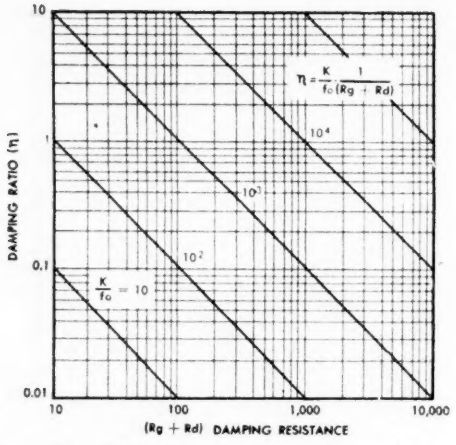


FIG. 4. DAMPING RATIO vs damping resistance.

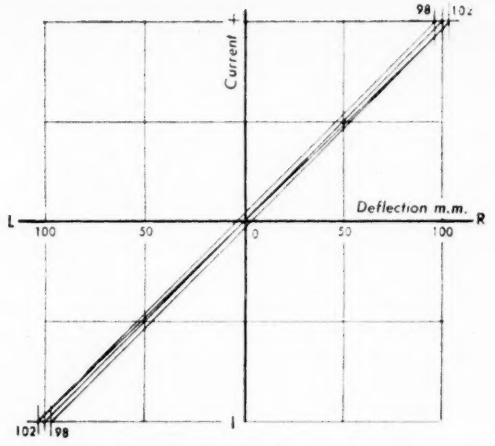


FIG. 5. LINEARITY CURVE shows effect of optical-system geometry.

Fig. 4. The damping resistance in ohms is the total of all resistance in the galvanometer circuit, including the galvanometer coil. The damping ratio is the ratio of the actual damping to the critical damping.

In Fig. 4, f_0 is undamped natural frequency, R_g is galvanometer resistance, and R_d is resistance specified for optimum damping ($\eta = 0.64$). Using these data (found in the manufacturer's specifications), Fig. 4 gives the value of K/f_0 at $\eta = 0.64$. The slantline curve (K/f_0) that passes through this value then can be used to answer the questions such as (1) what is η for any given value of R_d?, (2) what R_d will give a specified η?, etc.

Damping-Ratio Check

A check of the damping ratio of a given galvanometer can be made by several techniques, including calculations based on overshoot in the leading edge of a square wave, and on decay of successive cycles of an oscillation induced by a step function. These techniques are reported in the literature.*

Linearity

The curve in Fig. 5 shows the actual deflection of a galvanometer spot in relation to the current through the galvanometer coil. The deflection is in millimeters measured from a plane 30 cm from the galvanometer mirror. The current is in arbitrary units, thus making the curve applicable to all galvanometers.

The deflection of a galvanometer spot should be proportional to the current through the coil and there should be no difference between deflections with increasing current and deflections with decreasing current. However, linearity depends on coil design, field distribution, optical system of the instrument, etc. In no case should the wattage rating of the galvanometer be exceeded. Most galvanometers will give a trace deflection of ±100 mm without exceeding their wattage rating. The accuracy of this deflection for the required current is ±2%. For smaller deflections it will be within the limits shown in Fig. 5. Greater accuracy can be attained by individual calibration.

Figure of Performance

A commonly used *figure of performance* (F.P.) for comparing galvanometers on the basis of galvanometer sensitivity and undamped natural frequency (f_n) is as follows:

$$F.P. = KSf_n^2$$

where K = a constant (10^{-4}), and S is sensitivity in mm/μa at 1-meter optical arm.

Galvanometer Types

Galvanometers are available in wide ranges of frequency and sensitivity. Magnetically-damped galvanometers are available with natural frequency above 600 cps. Fluid-damped galvanometers are available with natural frequency above 3000 cps. These higher frequency galvanometers are less sensitive than the lower-frequency models. Sensitivities up to about 0.5 in/μa deflection at a 10" optical arm are available in low-frequency galvanometers.

Integrating-type galvanometers are available which mechanically integrate the output of a velocity-sensitive pickup to give direct indication of displacement. A standard galvanometer can be so adapted over a limited frequency range by overdamping it about 6 times critical damping ($\eta = 6$).

Computing type galvanometers have been designed to give direct readout of power ($EI \cos\theta$). These are similar to electrodynamometer movements, with two stationary and one moving coil, the moving coil carrying the mirror.

Ballistic-type galvanometers are those whose response time is so slow that input signal (pulse) is back to zero before any coil motion results. These are usually low-frequency galvanometers, but standard ones can be adapted by overdamping to about 20 times critical ($\eta = 20$).

*Alvin B. Kaufman, "Measurement of Damping and Natural Frequency," *Instruments & Automation*, Dec., 1955.

Evaluation Factors for Recorders

GEORGE PIHL

Acton Laboratories, Inc.

Recorders can be compared on the basis of resolving power, time factors, and operation cost.

ONE CRITERION used to evaluate direct-writing oscillographic recorders is the frequency response of the system. Most direct-writing recorders today are able to reproduce at least 100 cps and some, using light-beam galvanometers, several thousand cycles. Often overlooked is the factor of resolution, which in many cases can be a limiting factor in the usefulness of the recording obtained.

Resolving Power Comparison

Considering the first limitation, resolving power comparisons can be made among various methods of recording by comparing the trace width with the physical length of one cycle on the film. This must be done at the recorder's maximum practical film speed and with identical frequencies to give a true comparison.

Resolving power R is defined at any frequency as the ratio of the length of a cycle to the trace width.

$$R = L/W$$

where W = trace width and L = length of cycle

Fig. 1 indicates typical results obtained from sample recordings made on three systems.

Trace Width

Another comparison of resolution characteristics between recorder types involves the variation in trace width, depending on the recording method used. Recorders using a scribing or writing method have essentially constant trace width, independent of frequency, film speed and waveshape. In contrast, recorders using light-beam galvanometers expose the film in accordance with the instantaneous spot speed.

Film Capacity and Time Factor

The next question often posed concerns the amount of recording that can be done on a given length of film, or how much film is required to record a specified quantity of information.

In order to compare time factor, it is necessary that a firm basis of comparison be chosen. Since it is desirable to show various recorders under equal conditions, the frequency must be the same for each type compared. In addition, since it is desired that information usefulness be the same, identical resolution factors must apply, or be compensated for.

Time factor can be defined as the ratio of the total length of film that can be stored in the recorder to the speed necessary to produce a given resolution at a given frequency.

This factor can be expressed by:

$$T = RM/S_{max}.$$

where R = resolving power at maximum speed, S_{max} = maximum speed. M = total length of recording medium.

For a given kind of information to be recorded, the time factor, therefore, is a measure of the recording capacity of the system. For the Action 550-A scribe-type system, R = 1.050; M = 65′; S_{max} = 6.3″/sec. Hence T = 10,830.

This time factor figure is an order of magnitude better than for some other types of recorders.

Operation Costs

After initial investment, the two major costs of recording are the film or paper costs and costs of development of film, if any. Of these, the film or paper cost is by far the greater, and comparisons are made on this basis.

As with resolution and time factor, cost of operation must assume, for proper comparison, equal frequency and equal (or properly compensated) resolution. The cost factor (C) depends on the actual price of the film (P), and the time factor (T). The resolution compensation and length of film already appear in T and the frequency has been assumed equal for various recorders.

Thus, C = P/T. The cost factors of the ALI 550-A scribe recorder are: Price of chart or film = $5.00 (65′): T = 10,830. Hence $C = 4.61 \times 10^{-4}$. Other recorder types have higher cost factors.

Conclusion

Comparison of recorders yielding equal resolution, and with comparable frequency response, results in a wide differential in operating cost. The cost analysis given permits direct comparison of all types of recorders.

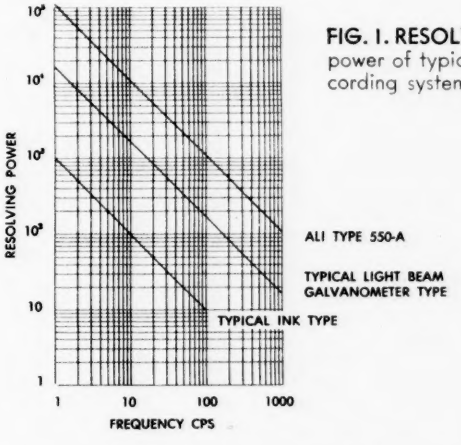


FIG. 1. RESOLVING power of typical recording systems.

Recent Advances in Oscillographic Measurement

The temperatures, stresses and pressures found in modern, highly-complex jet engines require precise recording instrumentation, particularly for measurement of transients. Here are the data-recording requirements and equipment solutions found satisfactory for one jet-engine test facility.

R. H. CERNI

General Electric Company

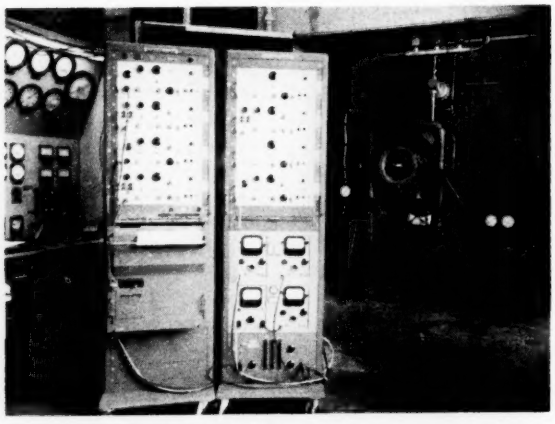
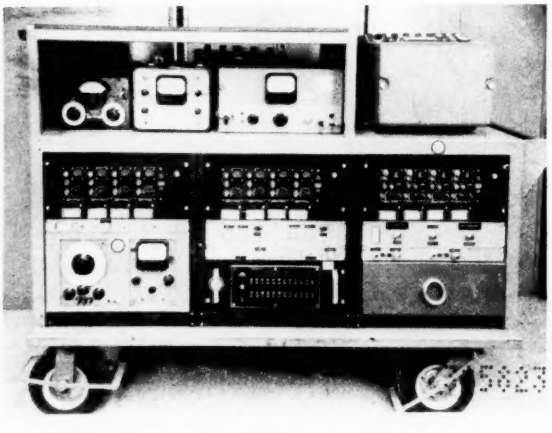


FIG. 1. DIRECT-WRITING oscillograph mounted in mobile racks for rapid test setup at jet-engine development cell.

FIG. 2. MOBILE 36-channel photographic oscillograph system.



DYNAMIC measurement test programs require records of many inter-related variables—electrical, hydraulic (pressure), and mechanical (position, load, stress, deflection). In jet-engine testing at the Small Aircraft Engine Department (S.A.E.D.) one or more traces normally represent the power input (forcing function); others plot the resulting changes in dependent variables (performance), of an experimental engine (Fig. 1).

More than 90% of the measurements made in engine testing do not exceed 100 cps, which is within the response of the inkless recorder. Another advantage of the inkless system is its readiness for immediate use at any time. Inking systems require considerable effort after a period of inactivity to clear the recording pens. The paper used in these machines is ordinarily opaque, but transparent inkless recording paper is becoming available.

Photographic oscillographs are used to record transient phenomena which may vary as rapidly as 5,000 cps (Fig. 2).

Table I lists the variables encountered in jet-engine testing, the primary elements, the output of the pick-up, the instrumentation required for recording, and the transient frequency range.

Until recently, transient-recording equipment used in the aircraft engine testing has not had sufficient versatility, stability, and fast response time. Some of

TABLE 1—OSCILLOGRAPHIC INSTRUMENTATION APPLICATION CHART

Measured Variable	Pickup Device	Measurement Performed	Instrumentation	Transient Freq. Range (cps)
Acceleration	Accelerometer (various types)	Detects motion of restrained mass	Carrier, universal amplifier, or bridge balance	0 to 800
Current	A-c or d-c shunt	A-c or d-c voltage	D-c amplifier and rectifier (a-c)	Limited by recorder only
Flow	Turbine type flow sensor	Produces a pulse rate proportional to flow	Integrator, d-c amplifier	0 to 100
Force, thrust load	Force Transducer (various types)	Measures analogous displacement or strain	Carrier or universal amplifier or bridge balance	0 to 200
Displacement, linear	Linear variable differential transformer	Linear change in output with linear displacement	Carrier or universal amplifier or bridge balance	0 to 2000
Displacement, linear	Translatory potentiometer	Output voltage proportional to displacement	D-c amplifier and d-c source	0 to 5
Pressure: absolute, gage, or differential	Pressure transducer (various types)	Made to represent analogous strain or displacement	Carrier or universal amplifier or bridge balance	0 to 2000
Shaft position	Precision rotary potentiometer	Output voltage proportional to angular position	D-c amplifier and d-c source	0 to 5
Speed	Magnetic pickup coil	Gear tooth causes pulse output as it passes coil	Integrator, d-c amplifier	0 to 200
Speed	A-c tachometer generator	Frequency proportional to speed	Integrator, d-c amplifier	0 to 10
Stress-strain	Strain gage elements	Change in resistance proportional to elongation	Carrier or universal amplifier or bridge balance	Limited by recorder only
Temperature point or differential	Thermocouple	Voltage is generated by dissimilar metals	Very high gain d-c amplifier and constant temperature reference unit	Limited by thermocouple only
Temperature	Resistance thermometer or element	Change in resistance proportional to temperature	Carrier or universal amplifier or bridge balance	0 to 10
Torque	Pickup device coupled to existing Emery system	Linear motion potentiometer or LVDT	Dependent on system used	0 to 1
Torque	Force transducer (various types)	Measures force of tare arm directly	Carrier or universal amplifier or bridge balance	0 to 200
Vibration	Velocity or vibration pickup	Self-generating type output may be converted to amplitude, displacement, or velocity	Special vibration level amplifiers or standard vibration equipment and d-c amplifiers	0 to 300
Voltage	Direct	A-c or d-c voltage	d-c amplifier and rectifier (a-c)	Limited by recorder only
Remote shaft position	Modified selsyn system	Selsyn receiver drives potentiometer at remote location	d-c amplifier and d-c source	0 to 5

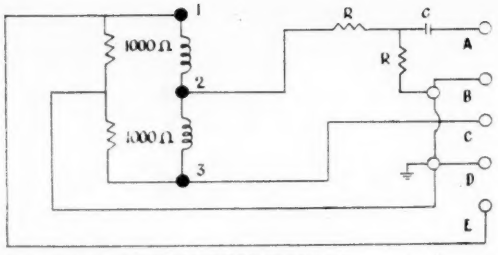


FIG. 3. LINEARITY CORRECTION for variable-reluctance pickup; input is across C-E and output is across A-B; D is grounded.

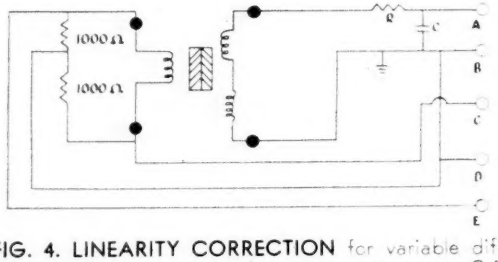


FIG. 4. LINEARITY CORRECTION for variable differential transformer transducers; input is across C-E and output is across A-B, with D grounded.

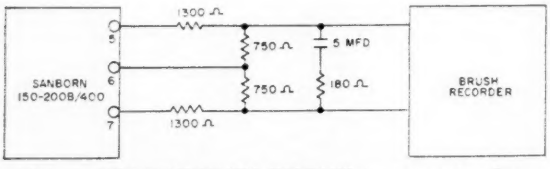


FIG. 5. COMPATIBILITY CIRCUIT to connect a Sanborn 150-200B/400 driver amplifier to a Brush recorder.

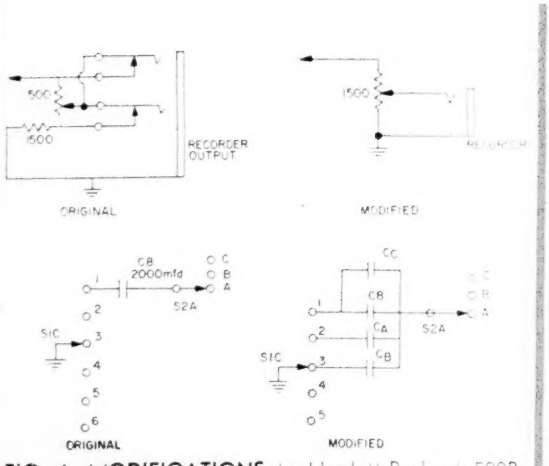


FIG. 6. MODIFICATIONS to Hewlett-Packard 500B frequency meter for use with direct-writing oscillograph.

the more serious restrictions included:

1. *Rapid setup.* Equipment used with direct-writing and photographic oscillographs usually has been entirely separate, and the measuring techniques used in each case have been different. Compatibility of equipment with all types of measuring systems and a means of rapidly calibrating and checking all channels is required.

2. *Stability.* Serious drift in d-c amplifiers has been experienced.

3. *Suppression.* Because of the need to investigate small variations which are part of large signals, precision-calibrated zero suppression is required that can be accurately set and changed during engine operation without recalibration of the system.

4. *Response time.* On certain measurements, such as speed and flow, the response time has been found to be far less than the capability of the associated oscillographic equipment.

Commercial transducers are now available which perform satisfactorily in the large majority of measurements to be made. In the past few years standard, or slightly modified, commercial equipment which meet most of the required performance specifications has become available. An oscillographic instrumentation application chart (Table 1) lists most of the measurements currently made of transient phenomena at SAED.

D-c amplifier drift can be eliminated completely by using highly stable and balanced (push-pull) circuitry with electronically regulated power supplies for low- and medium-gain amplifiers. Many power supplies of the new amplifiers contain such circuitry. For high-gain requirements, chopper-stabilized and chopper-amplifiers are used, depending on frequency response needed. Such units are available as plug-in preamplifiers.

Precision-calibration *zero suppression* is included in many new amplifiers and preamplifiers. Much of the accessory equipment currently being used contains either a-c or d-c suppression. This permits direct suppression of measurements such as temperature, pressure, speed, and flow without recalibration, and also permits increased accuracy since a small portion of the total measurement can be expanded or "blown-up."

Response Time

Transient response for speed and flow measurement has been particularly slow in much of the equipment used previously. Speed and flow signals sensed with standard AN tachometer systems and turbine-type flow sensors have about a 70-cps output frequency at maximum condition. After suitable pulse-shaping and integration, not more than a 1- or 2-cps change can be recorded. Even with elaborate, complex filters, only 10-cps response has been possible. A solution is the use of sensors with a much higher frequency output. A modification has been designed which adds a gear and pulse pickup and a second end shield to a standard engine tachometer generator. These units provide a maximum of 2-kc output signal.

An investigation into flow sensors reveals that other higher frequency units are available with 2-kc response at flows that are considered maximum. Several manufacturers have introduced these units.

Preamplification is often necessary because the higher frequency signals usually have proportionally lower amplitude. The small phono preamplifiers for reluctance-type pickups normally used in hi-fi have been found to work well. Many pulse integrators or frequency meters in common use have the disadvantage of being inherently slow. They switch higher frequency signals through dividers to reduce all signals to a common low-frequency full-scale value and thus do not improve response time. Fast-response-time frequency-to-voltage conversion units and frequency-meter preamplifiers also have been introduced recently for transient measurement: some of these have calibrated zero suppression. Such equipment is now suitable for measurement of speed and flow.

Linear variable differential-transformer transducers often appear nonlinear on oscillographic strain-gage (carrier) amplifier equipment. Reluctance transducers also can exhibit marked nonlinearities when used with oscillographs. This is usually caused by the phase shift these transducers introduce between the input and output circuitry. When remedied by simple phase-correction networks (Figs. 3 and 4), these transducers become linear and can be balanced simply with the same controls that are used for strain-gage bridge-type transducers.

Modifications for Compatibility

Fig. 5 shows the circuit required to connect a Sanborn 150-200 B 400 driver amplifier to a Brush recorder.

Fig. 6 shows filter and ouput modifications made to a H-P Model 500B frequency meter for use with direct-writing oscillographs (Sanborn, Edin, Brush, etc.). Output circuit changes are shown at top; bottom shows filter circuit changes. C_C, C_A, and C_B are selected to produce desired alteration in ripple on the 10, 30, and 100 cps scale. Special Wang Laboratory equipment has been constructed that would work well with tachometers. The response is slow, but they are very accurate.

The study of transient records often requires the plotting of one variable against another. By coupling the output of Sanborn, CEC, or Brush amplifiers to a Moseley Model 3 x-y recorder, these plots may be made immediately. Speed of this system will be $\frac{1}{2}$ sec for full scale. The circuit is shown in Fig. 7.

Shaft position, remotely sensed with selsyn transmitters and read-out on radio compass, is recorded by means of a second receiver and extremely-low-torque (0.005 oz-in) potentiometers. This is shown in Fig. 8. The error introduced to the first receiver has been found to be negligible when perfect mechanical alignment of the second receiver and pot is obtained. Wiancko, Shaevitz, and Atcotran LVDTs often appear nonlinear on Brush or Sanborn equipment. This is usually caused by the phase lag these transducers introduce between the input and the output circuitry. This is remedied by simple phase-correction networks, as shown in Figs. 9 and 10.

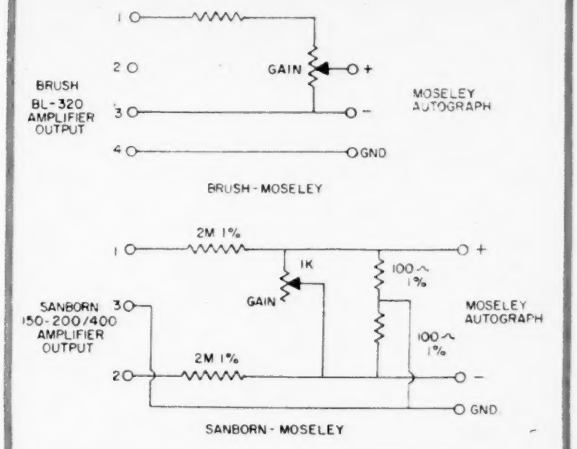


FIG. 7. ADAPTATION of x-y recorder to strip chart oscillograph for simultaneous transient and x-y plotting. (Could be adapted also for L & N or M-H type x-y recorders.)

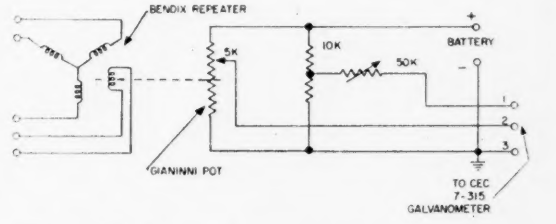


FIG. 8. REMOTE shaft-position/voltage converter.

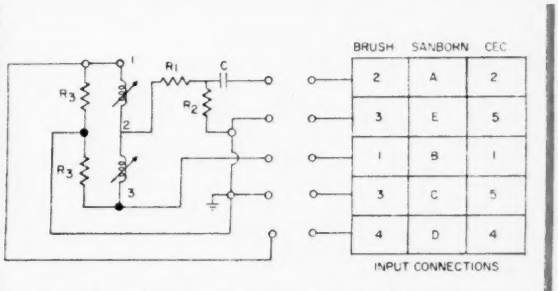


FIG. 9. LINEARITY correction for reluctance pickups.

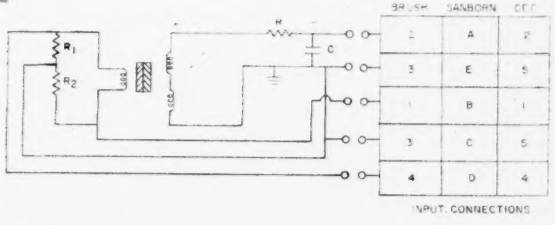


FIG. 10. LINEARITY correction for linear variable differential transformer.

Recording Oscillographs in Aircraft and Missile Testing

Here is how recording oscillographs are used in aircraft and missile testing to record strains, vibrations, temperatures and engine performance—and to detect cause of crashes.

WILLIAM F. JOHNSON

Consolidated Electrodynamics Corporation

RECORDING OSCILLOGRAPHS and vibration meters were used recently to prove out the redesigned Grumman F11F-1F "Tiger" Navy Jet fighter. The redesign included a larger General Electric J-79 engine and afterburner.

Installation of the new powerplant had required only relatively minor revisions to the basic Tiger airframe, such as increasing the capacity of the inlet ducts and rebuilding the aft fuselage for a large afterburner. But to the instrumentation engineer the modification presented an entirely new airplane—particularly in testing for engine vibration.

Flight-test programs included structural load buildup and demonstration, stability and control at high speed, aircraft carrier suitability, and flutter. In the flutter program, accelerometers or velocity-type pickups were located in the wings, vertical fin, stabilizer and at the center of gravity of the airplane. During the buildup, the airplane was stabilized at varying altitudes and airspeeds and the airplane excited in some manner.

During the pulsing or shaking, certain pickup signals were fed to telemetering channels while most of the signals were put into a recording oscillograph. The telemetered signals were fed to a direct-writing instrument on the ground for visual observation and basic analysis while the flight was in progress. An audio channel was used between the pilot and ground personnel, who may stop the buildup when flutter points were approached. The oscillograph data provided more detailed information after the flight was completed.

Recording oscillographs were used in the test plane for recording data during flight. A 50-channel oscillograph was installed in a mobile telemetering van and used for recording while the flight was in progress, or for recording data from magnetic tape.

Vertol Helicopter Tests

In designing high-performance helicopters of minimum weight, it is necessary to determine accurately the stresses in all parts of the helicopter, including the fuselage, control systems, transmission and rotor blades.

Typical of the extensive tests necessary in helicopter development were those made by Vertol Aircraft Corporation on the HUP-4 Navy helicopter. This testing consisted of an intensive rotor-blade and engine-drive system strain survey.

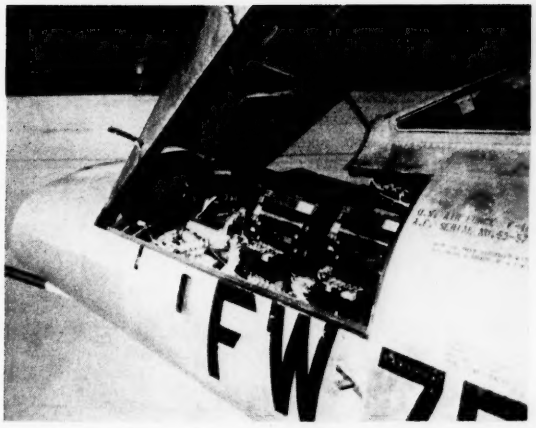
Strain gages were applied to one blade of each set of three rotor blades. Forty bridge networks were installed and arranged to measure flap and chord bending-stress distributions, torsional stresses at the root end, and stress at any point even remotely considered questionable. The blade positions (flap angle, lag angle, and pitch angle) were also defined as the instrumented blade passed about its azimuth.

The bridge and blade-position-pickup signals were transmitted through an 88-ring slip-ring assembly, passing through the gear boxes to the main distribution panel. From that point the signals were transmitted to a Recording Oscillograph.

High-frequency, low-level strain phenomena were measured throughout the engine drive and control systems. Rotor- and engine-induced vibrations were detected through the fuselage, the velocity-pickup signals being transmitted to matching networks and linear-integrating amplifiers. These signals were similarly fed from the amplifier output directly to the oscillograph.

Testing Rocket Engines

Recording oscillographs are being used to design and test the engines which are powering our missiles and rockets. For example, tests of solid propellant



CLOSEUP OF FLIGHT test instrumentation on the North American F-100 (above), shows two recording oscillographs and amplification equipment. F-86 Sabre fighter (right) also is carrying two recording oscillographs.

rocket engines made by Grand Central Rocket Company for Project Vanguard were tested with Recording Oscillographs.

The solid propellant rocket engines were tested in Cape Canaveral's six static firing bays or tunnels—each equipped for horizontal firing of solid propellant motors. Up to 100,000-lbs thrust can be handled. In a block house on "Test Hill" behind the bays is the instrumentation room housing rackmounted chart recorders, timing pulse generator, a 16-channel thermocouple multiplexer, self-balancing potentiometers, d-c amplifiers, and an oscillograph-photo set-up.

Signals from thermocouples and accelerometers mounted on the motor are brought through a central patch arrangement to any piece of equipment. All galvanometers in the oscillographs are brought out to phone jacks in a standard audio patch panel. This cabling arrangement makes for a very flexible data-recording center.

With the motor fastened to its mounting and connected, the oscillograph magazines loaded and instruments checked out, control of the firing goes over to a central console. From this point on, control is automatic. The recorders have been set to go on at minus three seconds and stay on for the predetermined duration.

Solving Causes of Crashes

Recording oscillographs, operating even after human failure, often give silent testimony about the causes of apparently unexplainable accidents. A major clue to the crash of a North American F-100, for example, was provided by a Recording Oscillograph.

The oscillograph photo-sensitized paper record was one of the objects recovered from the wreckage, along with broken instruments and the plant and engine fragments. NAA's chief test pilot George Welch could not tell what happened. The routine test flight was his last.

Though light-struck, the records were salvaged and made readable in a delicate developing operation. In the oscillograph tracings, the engineers "read" an unexplainable phenomenon. As the pilot began his dive, the nose shot upward and to the right. In a split second, before the pilot had time to get the plane under control, it went into a high, nose-right yaw. The opposing forces resulting from the sudden change of direction, made while flying at supersonic speed, ripped the plane apart.

This yaw, and other maneuvers of the airplane were faithfully recorded on the photosensitive paper record in the oscillograph.

SeaMaster Tests

Recovery of oscillograms from the crashed Martin XP6M-1 SeaMaster similarly provided information on the reason for the accident.

The giant Navy multi-jet seaplane was returning from a routine test flight to the Martin plant in Baltimore. While over northern Delaware, flying level at 21,000 feet and 600 mph, it suddenly went into a tight inside loop. Despite efforts of the pilot, the ship went out of control. The crew ejected, and the SeaMaster went into a downward spiral, breaking up at about 8,000 feet.

The ship was instrumented with Recording Oscillographs, used to measure acceleration, stresses, temperatures, system pressures, airloads, forces, positions, frequency, and vibration.

Investigators were able to recover intact oscillograms disclosing data recorded up to the last moment. It has now been determined that a tail modification caused aerodynamic forces to build up at high speeds, eventually forcing a sudden nose-down movement of the horizontal stabilizer.

Need for a crash-resistant oscillograph filter magazine has been met in the 5-032 Record Magazine, which will withstand 400-g shock and a 2,000°F fire

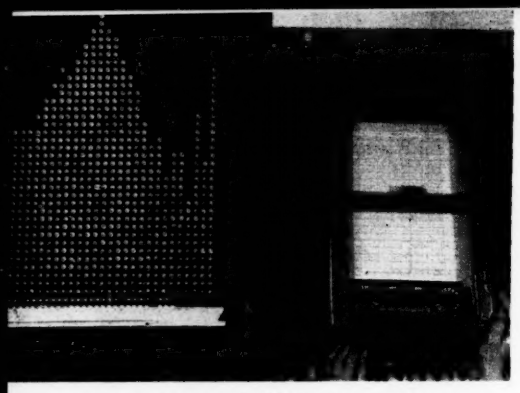


FIG. 1. CHARACTERISTICS of 2000 zener diodes are drawn per day at this test station using an X-Y recorder. (Courtesy International Rectifier Corp.)

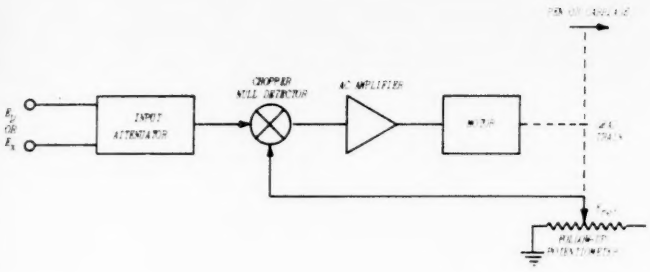


FIG. 2. EACH CHANNEL (x or y) of the X-Y recorder is independent of the other and is a recording potentiometer.

X-Y Recorders

E. J. SADLER
Electro Instruments, Inc.

X-Y RECORDERS are data-processing instruments that fill the gap between manual data taking and reduction and complex computers.

The X-Y Recorder combines the operation of measurement, plotting and curve fitting—all within a few seconds of time. It is a slow speed device compared to oscilloscopes and galvanometers, but very high speed compared to manual data taking. Its advantages include:

1. Plotting of a complex curve in less than 1 minute.
2. A permanent reproducible record on standard-size graph paper suitable for direct insertion in a report.
3. A second independent variable may be used to draw a family of curves on a single sheet.
4. A wealth of detail regarding the fine structure of the curve is available at no additional cost; uncertainties due to taking too few data points are eliminated.
5. Human errors due to interpolation, transcribing, computing and plotting are eliminated.
6. The effect of parameter changes are immediately obvious by drawing families of curves on one sheet.
7. The system is self checking by retracing the curve in the opposite direction.
8. Inherent high accuracy allows measurement of small differences between characteristics.
9. Analog computation is accomplished directly by zero offset, zero shift, summing, and ratiometer operation.
10. Hysteresis-type functions are handled easily.
11. For production testing, specially printed graph paper with numbered axes and spaces for serial number, date, temperature, operator, etc. can be obtained. Limit of error curves also can be printed on the paper.

Most X-Y recorders are self-balancing potentiometers (Fig. 2), with either flat bed or drum recording surface. The inputs are slowly varying d-c voltages (from millivolts to hundreds of volts). Capillary type ink pens are most common.

Characteristic of commercially available general purpose X-Y Recorders include:

Paper Sizes: Standard paper sizes of $8\frac{1}{2}$" x 11" and 11" x $16\frac{1}{2}$" are most commonly used: 30" x 30" sheets, 30" rolls, and strip-chart rolls are also available, as is precision paper.

Accuracy: The absolute accuracy of a point on a piece of paper is determined by: servo dead zone, the linearity of follow-up device (including loading errors), paper indexing, accuracy of printing and paper stability, thermal drift, mechanical backlash, mechanical alignment, pen line width, reference stability, precision resistor stability, care taken in setting zero and in calibrating, precision of input attenuator resistors, etc. Accuracies to $\pm 0.1\%$ of full scale are possible.

References: Commonly used reference sources are mercury batteries, zener diodes, standard cells referenced to electronic supplies, and external references sources such as a ± 100-volt analog-computer reference supplies.

Scale Ranges: Sensitivities from 0.5 mv/in to 50 v/in in roughly 2:1 steps are available.

Speed: Slewing speeds vary from 10 to 40 inches per second. Higher speeds allow higher point plotting rates and better dynamic performance. Usable writing rates are roughly one half the slewing speed.

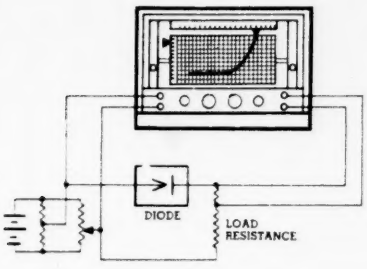


FIG. 1.

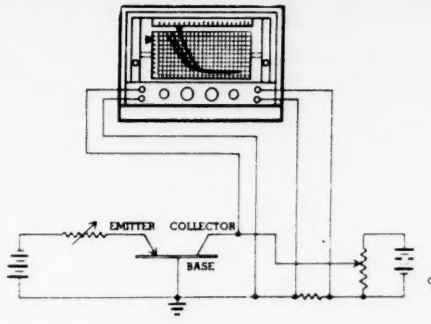


FIG. 2

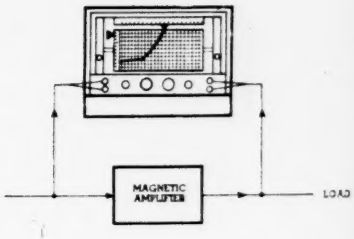


FIG. 3

Application of the X-Y Recorder

F. L. MOSELEY, F. L. Moseley Co.

CONVENTIONAL RECORDERS plot a variable against one independent variable—time, but the X-Y recorder can plot a given variable against any other variable, including time. For example, the X-Y recorder can plot, in a few seconds of time, the relationship between current/voltage, Eg/Ip, lift/drag, speed/torque, stress/strain, temperature/activity, temperature/pressure, etc., etc.

Conduction characteristics of diodes are quickly checked for routine production, or for selection in the manufacture of balanced modulators as shown in Fig. 1. Transistor characteristics to a high order of accuracy are made a matter of record quickly and easily, as shown in Fig. 2. In each case, all that need be done is to vary the independent variable; the dependent variable is automatically plotted against the independent variable.

Control characteristics of magnetic amplifiers can be viewed, adjusted, and recorded for file with the simple set-up shown in Fig. 3. Here again, only the control signal is varied; the amplifier output is automatically plotted against that signal.

High-rejection, precisely-adjusted filters are tested in production with the set-up shown in Fig. 4. Here the motor sweeps the frequency of the signal generator; the filter output is automatically plotted for each frequency. Speed of measurement and absolute reproducibility of results have been outstanding features of this application. Audio-frequency gain plots may be made in similar manner. Note that a complete response curve for a filter requires only a push of a button that starts the motor. Even this manual operation can be automated!

Transfer characteristics of valves can be tested in the manner illustrated in Fig. 5. As the valve is opened, the flow is automatically plotted against valve lift. The continuous nature of the data, as opposed to the more usual point-by-point tests, removes uncertainties and lessens disagreement during final inspection and acceptance tests.

The X-Y recorder is also used as an output table for analog computers. Ease of loading, accuracy, and multiple scales are features of value in this application. Whenever the relationship between two variables is desired, the X-Y recorder can supply an accurate, rapid answer.

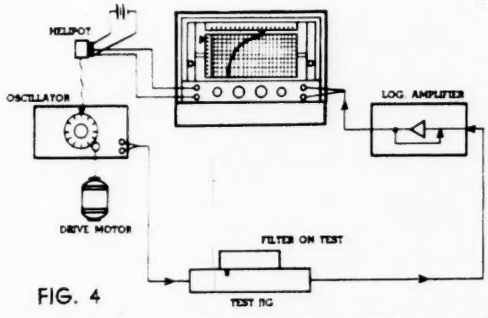


FIG. 4

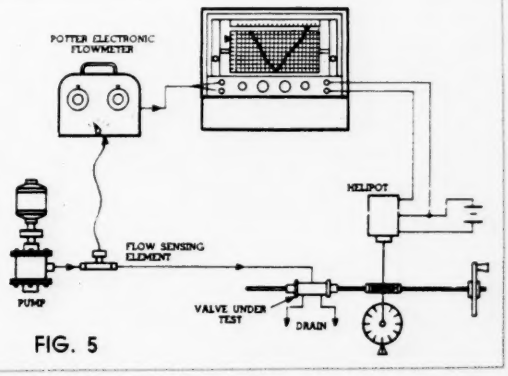


FIG. 5

Applications of the

GEORGE A. RUTLEDGE
The Bristol Company

Recording Potentiometer

THE COMPONENTS of the potentiometer (and bridge) instrument can be varied or rearranged in many different ways to suit particular requirements. Often the result is neither a pure potentiometer nor a bridge; however, all have one common characteristic —they are "null-balance" instruments. In other words, they balance an internal signal against an unknown signal and arrive at a balance so that there is no current in the measured circuit. This is a valuable characteristic, because there is no (or little) current drain from the equipment producing the unknown signal. For this reason the "null-balance" instrument has become universal for a host of detecting circuits.

Digital Readout

The potentiometer can record almost any variable. It is sometimes used with a read-out commutator which is attached to the instrument chassis and actuated by the slidewire shaft. The commutator is connected electrically to a translator and to a tape punch or automatic typewriter. This allows the information from the potentiometer to be printed in a column. A number of items may be "read out" and printed on a multicolumn sheet. This information then becomes the log sheet of a process.

Many applications use the potentiometer either individually or in combination with the output from another piece of equipment. There are a number of instances where two or more such instruments can be combined to obtain information, particularly where computing is involved. One of these is the *BTU recorder*. In this system one bridge continuously adjusts a pot whose resistance is proportional to flow; another bridge adjusts a similar pot whose resistance is proportional to temperature difference; a third instrument continuously multiplies the output of the two pots, and the resulting reading (if the temperatures and flow have been chosen correctly) is proportional to BTU.

One important application is neither bridge nor potentiometer. This is the *differential-transformer transducer and recorder*. Such a transducer makes a recorder almost a universal instrument. It may be actuated by any measured variable which can, with a suitable element, be converted into a small mechanical movement (such transducers are available for pressure, liquid level, flow, motion, etc.). In each case the primary element (helical pressure element, diaphragm element, differential-pressure unit, etc.) moves a core within a differential transformer. As shown in Fig. 2, the primary windings of this transformer (and a similar one located within the recorder) are powered with low-voltage ac from a transformer. The core of the unit within the recorder is clamped in place and the instrument, in effect, balances out the difference between the two transformers. Thus the null-balance recorder can record any variable, such as pressure, flow, etc. A variation of this development may make the differential-transformer transducer even more useful. It is a miniature recorder which takes up about the same space as a miniature pneumatic receiver.

Process plants are becoming larger, and requirements for centralizing control are becoming greater. As pneumatic transmission is limited in distance, it is surmised that this electrical system will fill a gap between the short-distance pneumatic systems and long-distance telemetering systems.

FIG. 1. USE OF RECORDER in gas chromatography.

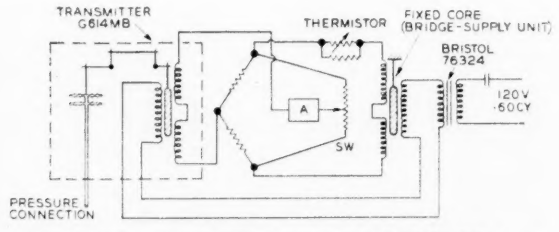


FIG. 2. USE OF DIFFERENTIAL-TRANSFORMER transducer as pressure transmitter with electrical output.

Recording in Medicine and Biology

ALONZO R. PARSONS
Minneapolis-Honeywell
Regulator Co.

FIG. 1. CATHODE-RAY OSCILLOSCOPE and recording electrocardiograph (direct-writing oscillograph used by surgeons and anaesthetists in operating room and cardiologist in connection with hypothermia techniques in heart surgery. (Photo courtesy The Oscillographer, Allen B. DuMont Laboratories, Inc.)

MEDICAL RESEARCH has made swift advances through its probings into the heart, the brain, the nervous system, and the muscular and respiratory systems. This task has been accelerated by oscillographic intrumentation.

Physical parameters such as pressures, heart beats, displacements, temperatures, oxygen content, and nerve and muscle potentials are converted to suitable electrical signals by transducers such as pressure pickups, crystal microphones, strain gages, thermocouples, oximeters, electrodes, etc. The transducers may be connected directly to the recording oscillograph, or it may be necessary to interpose a suitable amplifier or bridge-balance unit.

Heart studies are made by the ECG and vector cardiograph. The phono cardiograph, using a crystal microphone for heart sounds, performs as a recording stethoscope.

Biological pressures of all types are recorded, using small needles, catheters directly into the heart arteries, electromanometers, strain gages, physiological pressure pickups and differential transformer pickups.

Temperatures, usually sensed cutaneously or subcutaneously, are measured accurately by using small thermocouples and thermistors inserted in hypodermic needles. The slender needle overcomes previous disadvantages of introducing foreign matter, discomfort, and damage to the tissue.

Brain potentials and *nerve potentials* on electroencephalographs and in electroneurology studies use small and delicate pickup electrodes. Work is being conducted using microscopic-size electrodes for measuring individual cell potentials in frogs.

Circulatory system studies are conducted using a Plethysmograph or a pressure boot or cuff with an electromanometer, and measuring the changing volume of a digit to ascertain circulation efficiency. A ballisto-cardiograph provides another means of measuring circulation activity. This is accomplished by strapping the patient to a heavy, solid table mounted on strain-gage pickups. The strain gages sense the pumping action of the blood through the body producing significant records.

Abstracted from paper 55-9-4, 10th Annual Instrument Conference and Exhibit, Instrument Society of America.

Respiratory action generally involves the measurement of respiration rate, inhaled and exhaled air volume, chest expansion and contraction, metabolism, and oxygen content of the blood.

Muscle action is studied by the Myograph*. Simultaneous recording of velocity, acceleration and displacement to determine muscle contraction and extension under controlled or stimulated conditions is common. Strain gages, velocity pickups and accelerometers are available in a variety of forms for this application. The tokodynamometer, which measures exterior and interior muscular contraction during childbirth labor, is a specialized instance of muscular study.

Nuclear radioisotope techniques is a dramatic field in medical research. Counters and counting rate meters connected to the galvanometers of a photographic recording oscillograph can monitor the administration and absorption of radioisotopes, the distribution patterns and time-distance relationships. Radio-iodine^{131}, radio-phosphorous^{32}, and radio-sodium^{24} are three of the more common isotopes used in thyroid tests, cancer treatment, brain tumor localization, brain surgery and as tracers in blood flow studies.

Physiological factors such as blood pH, density, nitrogen content, and others are often desired on multichannel oscillograph records for comparison with many of the variables mentioned previously.

An electrogastrograph for measuring minute electrical potentials inside the human stomach has been used to study such diseases as peptic ulcer, spontaneous gastric hemorrhage, and cancer of the stomach. The patient swallows a fine plastic tube containing a wire tipped with one or more minute silver electrodes. This conducts the stomach potentials to the recorder apparatus. The electrical activity of the bladder, uterus and intestines also can be studied with the electrogastrograph.

Survey of Recorders Being Used with Analog Computers

JOHN McLEOD

DATA in the following tables were received from 32 computer installations. The total number of answers exceeds this number (32) as most respondents mentioned several items in answer to each question.

TABLE 1—TYPES OF RECORDERS AND PLOTTERS BEING USED AS OF JUNE, 1957

Electronic Associates	25
Sanborn	21
Mid-Century	12
Brush	12
Home Made	11
Reeves	10
Moseley	7
Goodyear	6
Offner	4
Electro Instruments	1

TABLE 2—REASONS FOR PURCHASE

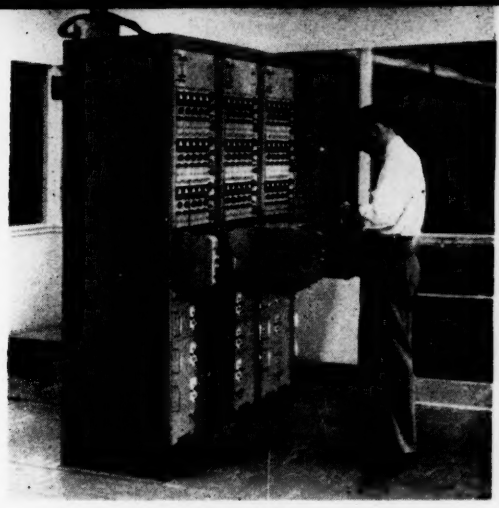
Came with computer	17
Economical	10
Convenience of operation	9
Rectilinear recording	9
Accuracy	6
Large area	5
Suits purpose	5
Most reliable	4
Frequency response	4
Versatility (flexibility)	4
Good visibility (readability)	4
No ink problem	4
Best available	3
Heated stylus	3
Small amplifier drift	3
High speed	3
Vacuum hold-down feature	3
Only one available at time	2
Speed selection	2
Reproducibility	2
No. of channels	2
Cleanliness	2
Reasonable band width	1
Previous experience	1
10" x 15" easier to handle than 30"	1
Flat surface	1
Low-cost paper	1
Typed and tape readout	1
Low speed	1
Low upkeep	1
No phase discrepancy	1
Curve-following feature	1
Good delivery	1
Pen lift feature	1
Portable	1
Speed stability	1
Resolution	1
Smoothness of tracking	1
Home-made	1

TABLE 3—FEATURES DESIRED IN NEXT RECORDER

Multi-channel recording	7
30" X-Y Plotter	5
Rectilinear coordinates	4
Digital read-out	3
Printed read-out	3
Small X-Y plotter	3
Data reduction equipment	2
Stabilized amplifier	2
Precision high-speed recording	2
Output useable in digital computer	1
Frequency-response sweep and plotter	1
Automatic calibration	1
Automatic programming	1
Wide scale	1
Smooth ink flow	1
Little paper drift	1
Contrast control	1
Ease of operation	1
Low cost	1

TABLE 4—IMPROVEMENTS DESIRED FOR ANALOG OUTPUT RECORDING EQUIPMENT

Increased accuracy	6
Increased frequency response	5
Rectilinear coordinates	4
Run numbering device plus record of gain setting	4
Multi-channel 4" recorder rectilinear with 3 or 4 channels with quick access to record	3
Larger chart	2
Greater reliability	2
Easily reproducible transducer output	2
Simultaneous setting of a group of potentiometers	2
Less paper drift	2
Better ink flow	2
Better reproducible hot-wire recordings	2
Auxiliary timing unit	1
Combination marker generator and true time-control device	1
Elapsed-time signals to stop computer	1
Three-dimensional plotter	1
Optional digital read-out	1
Convenient calibration	1
Greater ease of operation	1
Quicker reduction of data	1
Better checking system by direct reading from analog into digital computer or tape storage	1
Mechanism for feeding into digital computer	1
More channels per time base	1
Polarity indication on chart	1
Memotron tube with recirculating tape memory for accurate print-out from fast repetitive solution	1
Long-term stability of operational amplifiers	1
Removable patch panel	1
Good digital display of 10 channels	1
Analog output equipment with more automatic calibration	1
Automatic timing check	1
High-speed a/d converter for sampling analog output several times per second and presenting output in tabulated column of numbers	1
Low distortion	1
Smooth paper drive	1
Printed name of parameter in each channel	1
Printed value for FS or ICM deflection	1
Printed date	1
Re-run new traces over old	1
Wider traces	1
Smoother paper speed shift	1
Better paper for styli	1
Improved dynamic response characteristics	1
Higher speed than servo-type plotters with higher accuracy than galvanometer-type recorders	1
No wet process	1
Greater speed of response	1
Calibration indicator	1
Better pen adjustment along time axis	1
Less weight and bulk	1
Chopper-stabilized amplifiers with hot-wire recording system	1
Increased resolution	1



MAGNETIC-TAPE-TO-OSCILLOGRAPH system at General Electric's Missile and Ordnance Systems Division in Philadelphia. Missile flight-test tapes are played into the system by Ampex FR-100 tape recorders (left), and are routed by a "telephone-switchboard" relay system. Data are read out on as many as 30 simultaneous 15-channel Midwestern oscillographs (three are shown at right).

Graphic Recording via Magnetic Tape

ROY W. PYBURN
Ampex Corporation

MAGNETIC TAPE RECORDERS can give graphic devices extended range in five important areas: (1) frequency response, (2) recording time, (3) number of time-correlated channels, (4) data selectivity, and (5) system mobility.

The value of initial magnetic tape recording is that you can "look" at the data, cut and rearrange it where useful, then use it to drive your recorder after you have decided which portions are important and what methods will achieve desired writeout.

The tape recorder can be used to extend *frequency-response*. Simply by slowing down the tape in any available ratio, 5000 cps can become 652, 500, 156 or even as little as 50 cps. Tapes can be recopied to reduce the ratio further. Milliseconds can be stretched to look enormous and even a few microseconds can be stretched out into a visible interval. Working in the other direction, low-frequency taped information can be speeded up to compress time or get data into more convenient frequencies.

In addition to this multiplying or dividing of frequencies, a tape recorder permits signal *amplitudes* to be adjusted to permit side-by-side comparison of widely differing traces. You can eliminate undesirable trace overlapping and bring important weak signals up out of the "grass."

Also, since magnetic-tape data are electrical, it is possible to transmit it over phone lines or radio links to another tape or visual writeout device at a distant location.

Data Selectivity

Magnetic tape makes it possible to select the important parts of any test after it has run instead of before. Because of the density of information that can be recorded on tape, one reel can hold from 8 minutes to many hours of data from a test that might otherwise require hundreds or even thousands of feet of paper. Visual scanning with an oscilloscope permits selection of only the important data for graphic recording.

Then, if study of this information raises further questions, the experimental information is still available for further investigation. Data can be stored indefinitely, and referred to anytime a brilliant afterthought calls for a new analysis. Or, if all significant data have been analyzed, the tape can be erased and used again.

Time Correlation

If part of the problem is getting exact time correlation between channels, servo speed control on the tape recorder can hold errors in real time to less than 2 parts in 100,000. In addition, microscopically precise recording heads operating on a relatively narrow tape width can hold inter-track time-displacement error to 5 to 10 microseconds. On tape, track-to-track timing is held in its original relationship throughout any amount of slowdown. Slowing the tape down and copying onto paper moving at a relatively high speed stretches out the data and minimizes the effect of uneven paper travel and paper skew.

Mobility

When information must be recorded from a mobile environment there is a premium on compactness in relation to time durations, data frequencies and numbers of channels to be recorded. Magnetic tape recorders have this advantage and also are less affected by noise, vibration and adverse environmental conditions than are most visual-trace recorders.

Multisegmental recorders can save panel space by giving maximum information on a minimum of chart space. The sweep-balance technique is particularly well adapted to multisegmental recording.

GEORGE KEINATH

Larchmont, N. Y.

Sweep Balance Recording

ALL RECORDERS use either deflection or indirect techniques for putting signal data on paper. The first electrical recording instruments were of the direct-recording D'Arsonval-movement type, which is still a basic type of recorder, fully satisfactory for applications where sufficient energy is available from the source and where long lead length is no problem.

In order to adopt this principle to D'Arsonval movements with insufficient power to position a pen, the chopper-bar recorder was developed, with the pointer bar pressed periodically against the chart surface, which was often waxed or smoked. This type of recorder was developed in Europe and still is in general use there.

The basic disadvantage of direct-deflection techniques is sensitivity to line resistance. This is overcome in null-balance indirect-type recorders in which a bridge is balanced and no current flows at the balance point. This type of recorder is in general use; recorders are available with "fast" response (full 10" chart traverse in less than a second) and high sensitivity (microvolt input).

The modern trend to multipoint recording brings out a basic disadvantage of the null-balance-type recorder: even one second per point is excessive if 100 or more points are to be recorded. Further, overlapping recording of even 10 or more points causes a confusing pattern.

The result is increased emphasis on (1) *segmental recorders*, in which segments of the chart are used for specific variables and (2) *sweep-balance* recording technique, in which completely electrical means are used to detect the magnitude of the electrical signal, permitting recording in millisecond intervals rather than in seconds.

Segmental Recorders

Segmental recorders have been manufactured by several American companies for many years. The instruments belong to the multiple time base group and operate with null-motor-type pen recorders.

So far, multiple industrial recorders have used two of the three possible methods for balancing a potentiometer: one is the *step-by-step* method, introduced by Leeds & Northrup about 1912 with the "MICROMAX" recorder, the other is the *null motor* method, also developed first by L&N with the "SPEEDOMAX" recorder, about 1932. The third method is *sweep balance*, which was used by the author in his segmental recorder first built in 1943. The sweep-balance principle may be more readily adapted to multipoint recording than the other types. For example, with sweep balance, 100 or more potentiometric recordings per second are possible.

Sweep-Balance Technique

The sweep-balance technique uses either (1) a sweep-synchronized stylus and time-driven chart or (2) a steadily moving chart and time-driven stylus. In either case the motion of the stylus (or chart) is synchronized with a sawtooth waveform and, at the one

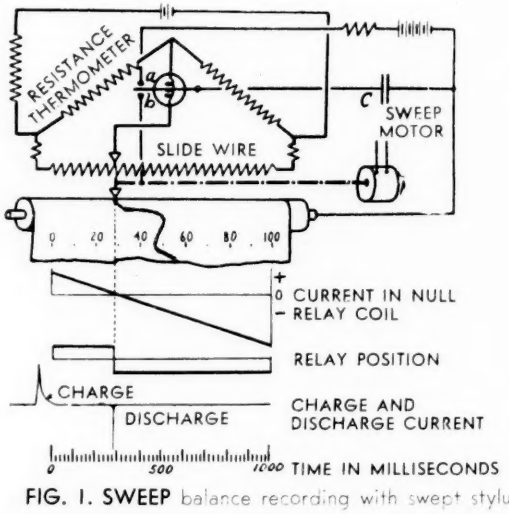


FIG. 1. SWEEP balance recording with swept stylus

point where the amplitude of the sawtooth signal exactly equals that of the variable to be recorded, the stylus is energized to make a point mark on the chart.

Fig. 1 shows the principle of a single-channel recorder using a swept stylus. The stylus is swept across the chart at any desired rate. A sawtooth waveform is developed in synchronism with the stylus motion. At the instant that the unknown variable equals the amplitude of the sawtooth waveform, a mark is placed on the chart.

Fig. 2 shows the principle using an endless chart that moves continuously.

Fig. 3 shows a moving-chart recorder for 96 variables. The endless-belt chart has 24 segments, each recording 4 variables. Twelve of the segments are on the left side of the chart, twelve on the right.

If one measuring and marking system is used, the order of marking would be as follows: The first mark would be made in segment 1; the second in segment 2, etc., until the 12 segments on the left were marked; then signal 13 would be in segment 1, signal 14 in segment 2, etc., until 48 channels were recorded on the left half of the chart. The technique then would be repeated on the right hand of the chart for channels 48 to 96.

If a separate measuring and discharge circuit was used on the right half of the chart, the time for the recording of 96 channels would be cut in half.

If a 2-second sweep were used, the chart cycle would be 24 seconds, and the time to record 96 channels would be 192 seconds with one measuring circuit; 96 seconds if two measuring circuits are used.

Much higher speeds are possible. The chart can run at speeds to 300"/sec, each measurement can be made in milliseconds by use of electrosensitive paper, and any segment of the chart can be "stopped" and observed by stroboscopic technique.

Contrary to common belief, mechanical reliability of the continuously-moving endless strip-chart is high, as has been established by running a 30" chart of 10" Teledeltos paper 500,000 cycles at a speed of 100"/sec (sweep period 0.05 sec) without sign of wear. Also a commutator-type potentiometer (voltage divider) with 240 silver contacts has made 200 million revolutions at a speed of 20 rev/sec without any visible wear (noise level at the end of this test was less than one microvolt). This is indicative of the experience, gathered in many places over many years, that augers well for the hardiness and appropriateness of segmental recording using the sweep-balance technique.

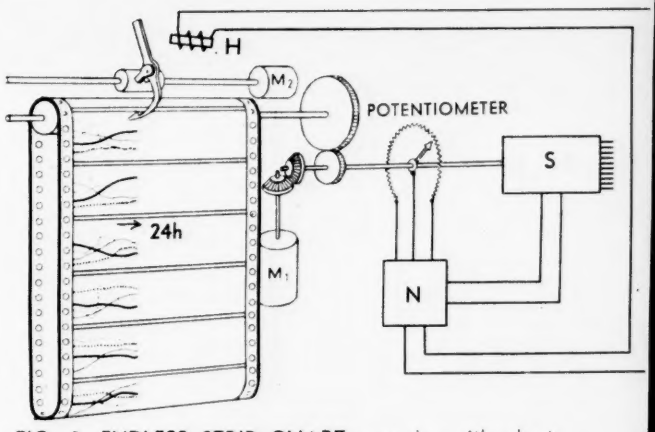


FIG. 2. ENDLESS STRIP CHART recorder with chart linked to sawtooth generator. Switch S selects unknown voltages for reading; M_1 is main drive motor; M_2 is clock motor; N is null indicator; H is electromagnetic-operated marker. The potentiometer develops a saw-toothed voltage for comparison with the unknown variables.

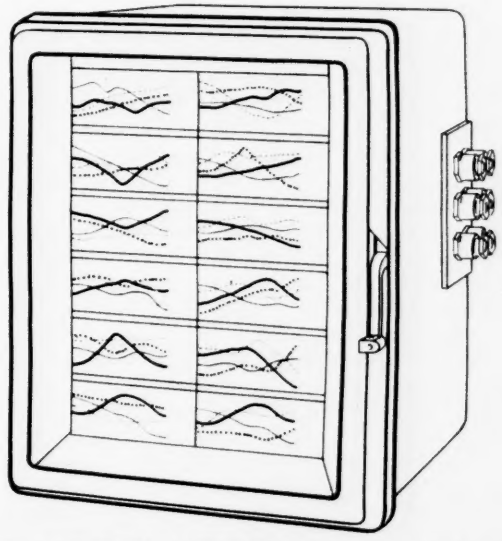


FIG. 3. UP TO 96 VARIABLES could be recorded in 24 segments using an endless-belt-type chart that moves continuously. Channel 1 is first recorded in segment 1 (say at lower left), channel 2 in next segment, etc., until 12 channels are recorded. Channel 13 is then recorded in segment 1, channel 14 in segment 2, etc., until 48 channels are recorded on the left half of the chart. The process can be repeated on the right side, or another measuring and marking circuit can be used. If the chart is rotating at high speed, any segment can be "stopped" and observed by stroboscopic technique; or entire chart stopped for examination. The time base is horizontal (across the chart).

References

1. George Keinath, The Keinath Recorder, *Instruments*, Vol. 19, April 1946, pages 200-210.

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3. C. G. Dell and L. P. Haner, Segmental Recorders, Conference on Electrically Operated Recording and Controlling Instruments, AIEE Publication S-52, Nov. 1952 pages 152-160.

4. High Speed Multi-Point Recorder, Sperry Products, Inc. *Instruments*, vol. 22, October 1949, page 914. See also Sperry publications 80-100 and 80-105 "Speedsweep Recorder."

5. Roger Brown Loucks, High Speed Graphic Sweep Recorders derived from the Keinath Scanning Technique, U S A F Technical Report 5964, October 1949, 9 pages.

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Automatic Reading and Analysis of Charts

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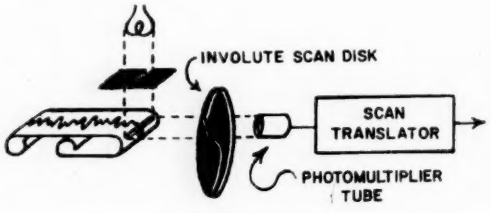
"How do we read and analyze this many charts?" is a common question. It often is necessary for technicians to read and analyze quantities of charts by manually operating "curve-followers," and then to compute reciprocals of trace ordinates, etc. This process is laborious and too often a victim of built-in "human-element" inaccuracies. An automatic chart reader and computer is now available.

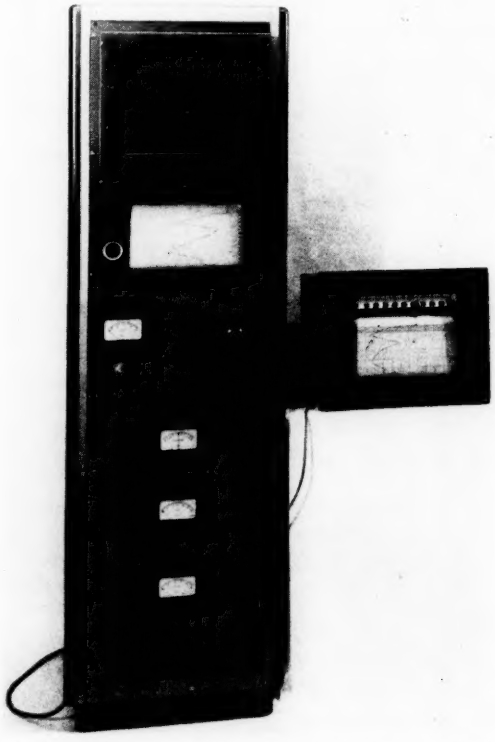
The basic reader consists of an optical projection system, a scanning system, and electronic circuitry. It is located so that a thin strip of light, focused on the chart at right angles to the long axis of the chart, reflects a narrow cross-sectional image of the chart onto a rotating scan disk. The dark trace of the chart



does not reflect light; however, the white paper background on either side of the chart does reflect. Therefore, the strip of light imaged on the scan disk appears to be broken by a dark "spot." When the drive is turned on and the chart is set in motion, this spot moves back and forth across the surface of the disk exactly as the trace undulates on the chart. The rotating scan disk is made of glass with an opaque coating through which two or more transparent slits have been scribed.

The scribed slits are usually in the form of involute curves because a rotating involute provides a linear sweep and always intersects the strip of light from the chart at right angles. The type and number of slits scribed on the scan disk, as well as the rotational speed of the disk itself, may vary according to particular requirements. However, a speed of 2600 rpm and the utilization of two involutes are common.

As the disk rotates and its involute slit first intersects the strip of light imaged upon it, light is allowed to pass through the slit to strike a photomultiplier tube. As rotation continues, the involute next intersects the dark spot (the reflected trace) and light to the photomultiplier is momentarily cut off, generating a pulse. A reference trace on the chart, or reference marks on the disk, often are used to generate another pulse which defines the base of the chart. A gating circuit then forms a measure pulse whose duration is proportional to the spacing of these two pulses and, therefore, proportional to the ordinate of the recorded trace. By rotating the disk containing the two slits at 3600 rpm, the location of the ordinate of the trace is pinpointed 7200 times a minute. This system provides a continuous or periodic pulse-width output proportional to the trace ordinate of the moving chart accurate to $\pm 0.1\%$ of full scale.



Optional rack-mounted conversion units, employed in building-block fashion, provide either mechanical, digital, or analog output if the pulse-width output of the basic reader does not meet the particular requirement of the user. Operations such as additions, subtraction, multiplication, reciprocal functions, chart comparisons, integration, are easily performed.

Final output data may be displayed digitally, rerecorded on another oscillograph, or stored on magnetic tape, punched tape, or punched cards.

Automation has at last come to the aid of the data-recording and analysis engineer.

Proposal to be presented at the 1st meeting of the Systems Engineering Council, June 10, 1958, New York Coliseum; concurrent with the 4th International Automation Exposition and Congress. Comments are invited by the author. Also to be discussed are membership qualifications and other procedural matters.

Proposed Standards For The Practice Of Systems Engineering

GEORGE H. AMBER
*Amber & Amber

THE FOLLOWING comprises proposed "Standards for the Practice of Systems Engineering," hereafter called the *standards*. This version is for discussion and information only. When discussed, amended, and passed by a standards committee of the Systems Engineering Council, these *standards* would be the recommended practice for all who engage in Systems Engineering. Ultimately, after a trial period, a version of the standards might be accepted by the Systems Engineering Council as mandatory practice.

OBLIGATIONS OF GOOD PRACTICE

The practice of systems engineering calls for a high order of integrity, judgement, executive leadership, and creative and technical ability. The System Engineer's honesty of purpose must be above suspicion. His purpose is to act as a professional adviser to his client or employer. Such advice must be unprejudiced.

The Systems Engineer is charged with making many decisions between the customer (the user of the system), and the manufacturers of system components, and the contractors who install the system, and his client or employer. In dealing with customer, manufacturer, sales representative, contractors, and his client, the Systems Engineer must act with entire impartiality.

The Systems Engineer has moral responsibility to his professional associates, and to non-professional systems workers, and to the users of systems, as well as to the general public. The Systems Engineer's duties and responsibilities cannot be performed properly unless his motives, conduct, and ability are such as to command respect and confidence.

To promote the highest standards of conduct, and to advance the state of the art, the Systems Engineering Council submits the following basic principles for the guidance of everyone concerned with any phase of systems engineering:

A. A Systems Engineer's relation to his client depends upon good faith. Before undertaking any commission or assignment, he should explain the exact nature and extent of his services, and of his compensation therefor. Where a fixed limit of cost is established in advance of design, the Systems Engineer must be given freedom to determine the character of design and mode of system operation needed to meet as nearly as feasible the cost limit established, but should

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not be understood to guarantee the final cost of the system which will be determined not only by the Systems Engineers' solution of the fixed system requirements, but by the fluctuating conditions of the components and contractors market. An important duty of the Systems Engineer is to keep the client informed, during the progress of the design work, as to the probable cost of the system.

B. A Systems Engineer should consider the needs and stipulations of his client and the effect of his work upon the life and well being of the public.

C. A Systems Engineer may offer his services to anyone, on the generally accepted basis of commission, fee, salary or royalty; in the role of Systems Engineer, consultant, employee, advisor, or assistant, provided that he rigidly maintains his personal professional integrity. This means that Systems Engineers may practice as employees of corporations, but they must be careful in all instances to see that their own actions are in accordance with the ethical standards of their fellow Systems Engineers, the independent consultants.

D. A Systems Engineer should not make use of services offered by manufacturers of components, or vendors of materials, appliances and equipment, or contractors, which may be accompanied by an obligation detrimental to the best interest of the client.

E. A Systems Engineer's drawings, specifications, reports, and other documents should be complete, definite and clear concerning his intentions. They should detail the components selected, their arrangement, and the scope of the contractor's work. Also, how work is to be performed, and how it is to be paid for.

F. A Systems Engineer should promote the interests of his professional organizations (such as the SEC, AIEE, IRE, ASME, ASCHE), and do his full part of the work of those organizations. He should share in the interchange of technical information and experience with the design professions and the manufacturing and processing industries.

G. A Systems Engineer should inspire the loyal interest of his employees, providing suitable working conditions for them, requiring them to render competent and efficient services, and paying them adequate and just compensation.

H. A Systems Engineer should try to help those who enter the practice, by assisting them to acquire a full understanding of the functions, duties and responsibilities of Systems Engineers.

I. Finally, every Systems Engineer should do his part to forward ethics and sincerity in his profession. He must maintain a wholly professional attitude toward those he serves, toward those who assist him in his practice, toward his fellow engineers, and toward the members of other professions, and the practitioners of other arts. He should respect the distinction between professional practice and non-professional business enterprise.

MANDATORY STANDARDS

1. A Systems Engineer shall not accept any compensation for his services other than from his client or employer.

2. A Systems Engineer shall not render professional services without compensation. He shall neither offer nor provide preliminary services on a conditional basis by agreement with the client that if the contemplated project proceeds, he will be employed as its Systems Engineer.

3. A Systems Engineer shall not knowingly compete with another Systems Engineer on a basis of professional charges. Nor shall a Systems Engineer offer his services in a competition or contest.

4. A Systems Engineer shall not engage in the sale or manufacture of components used for systems. Nor shall he manufacture or sell complete systems. Systems Engineers employed by manufacturers of components must not engage directly in sales work, and they must base their designs on an objective evaluation of what components can be used to create the optimum system, regardless of who manufactures the components.

5. A Systems Engineer shall not knowingly injure falsely or maliciously, the professional reputation, prospects or practice of another Systems Engineer.

6. A Systems Engineer shall not attempt to supplant another Systems Engineer after definite steps have been taken by a client toward the latter's employment.

7. A Systems Engineer shall not undertake a commission for which he knows another Systems Engineer has been employed until he has notified such others of the fact in writing and has conclusively determined that the original employment has been terminated.

8. A Systems Engineer in soliciting work shall not divide fees except with professionals related to system design, and those regularly employed or known to be associated with his office.

9. A Systems Engineer may use paid advertising, but not self-laudatory, exaggerated, or misleading publicity. Factual materials, verbal or visual, which dignify the engineering profes-

sion or advance public knowledge of the Systems Engineers' functions may be presented through public communication media. Brochures may contain factual information concerning Systems Engineering work. Showing slides or pictures to a civic, educational, or fraternal groups, illustrating the works of System Engineers is proper, provided that no personal or self-laudatory statements are made.

10. The propriety of gifts sent by Systems Engineers to clients and prospective clients is a matter of discretion. The gifts should not be of such a substantial nature as to tend to influence the selection of a Systems Engineer.

11. All Systems Engineers shall conform to their State registration laws governing the practice of professional engineering. While this is highly desirable for all engineers who claim to work at a professional level, registration is mandatory for Systems Engineers who work as independent consultants.

12. Systems Engineers shall observe the written and traditional ethics of the engineering profession. Specifically, attention is called to the "Cannons of Ethics for Engineers," as prepared by the Engineers Joint Council.

13. A Systems Engineer shall, at no time, act in a manner detrimental to the best interest of the engineering profession, and the specialized practice of Systems Engineering.

CONCLUSION

Following the principles herein is the obligation of every Systems Engineer to further the development of Systems Engineering and to provide a firm ethical basis for all client-consultant-engineer-contractor relationships.

DEFINITIONS PERTAINING TO SYSTEMS ENGINEERING

TERM	DEFINITION	DISCUSSION
SYSTEMS ENGINEERING	Pertains to the design of systems comprised of a number of separate components and elements, rather than to the design of the individual parts of the system. Generally implies an approach dedicated to the consideration of all aspects of all parts of a system in toto.	It is true that systems engineering cannot always be separated from applications engineering because commonly components must be specially designed to meet system requirements. But Systems Engineering must be wholly objective. It can flourish only in an atmosphere of complete independence of approach, unfettered by any encumbrances of hardware, sales quotas, or company predilection for particular pieces of proprietary equipment. Systems Engineering assumes entire responsibility for satisfactory system performance. Ref: "Systems Engineering vs. Applications Engineering", Chalmer E. Jones, Jan. 1958, INSTRUMENTS & AUTOMATION.
APPLICATIONS ENGINEERING	Pertains to the adoption of components and system elements for their use as part of a system. Specifically pertains to the activity and technique associated with suitable installation of an existing product into a system in which it is to function.	
SALES ENGINEERING	Pertains to engineering activities performed primarily to induce sale of a product.	The term Sales Engineering is included here as a negative example of what constitutes a consulting engineer or Systems Engineer. The Sales Engineer's work is important, especially in the area of applications of specific products, but his job doesn't permit the objectivity needed for Systems Engineering.
SYSTEM	The complex of functional & operational devices by which control of a process is accomplished. While system usually refers to control, the system often refers to the process as a whole, including both work mechanisms & control elements.	While system usually refers to control, sometimes the system refers to the process as a whole. As a habit, Systems Engineers usage of system corresponds to production or industrial engineers usage of process.
PROCESS	A series of work operations directed toward a specific end result; manufacturing and "processing" operations, viewed as a whole.	Process pertains mainly to production and manufacturing; system pertains to the agency used to control the process. In general, the control system directs the operation of the energy consuming process.
CONSULTANT	A professional man who provides specific services such as advice, counsel, reports, designs, etc. on a fee or retainer basis, not on a salary.	A man may be a professional, such as a Systems Engineer, if he has the capabilities of a professional, and the professional attitude, and observes the ethics of a professional. He is a consultant only if he works on a fee-retainer basis. A professional employee is in a sense a consultant working for a single client—at least, that should be his attitude.
CLIENT	The person or organization for whom a professional man performs his services on a fee basis.	The client buys services. The professional Systems Engineer has no customers, for customers are those who buy products, not services. The employer may well sell products built on the basis of the Systems Engineer's services.
EMPLOYER	The professional man (such as a Systems Engineer) considers an employer to be a special case of client, who obtains the professional's sole services for a fixed salary.	

ELECTRONIC

PHASE COMPARATOR MEASURES AMPLITUDE OR PHASE

CHARLES F. KEZER

Digitronics Corp.

and

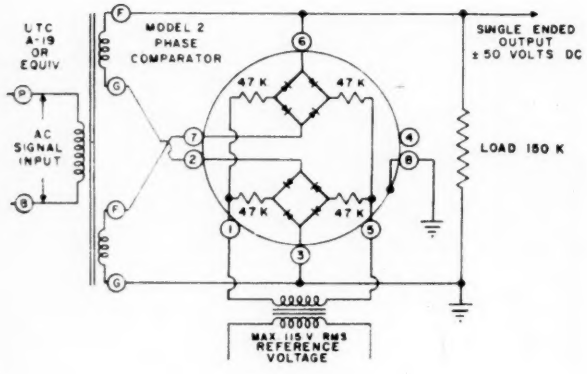
MILTON H. ARONSON

Instruments & Automation

This circuit can be used to measure the amplitude of a signal or its phase with respect to a reference voltage. Circuit is available as a small plug-in module from Sanders Associates, Nashua, New Hampshire. (Model 2). Plug-in unit contains four resistors and eight diodes: two external transformers are required to supply signal and reference voltages.

The eight diodes are arranged in two full-wave rectifier bridges. They are gated in and out of conduction by the reference voltage; only one bridge conducts at a time. Switching of the bridges by the reference voltage causes the signal to be passed through to the output in full-wave rectified form. Ripple can be removed with an external filter.

Suppose that during one half cycle of the reference voltage pin 5 is positive and pin 1 negative, and that



the signal is in-phase with the reference, with terminal F of the upper transformer winding positive, and terminal F of the lower winding negative.

The lower bridge is then conducting, providing a path for the upper signal input winding for current flow to the output load, and a positive half-cycle of voltage appears at the load. The lower winding is unable to produce output, as it is connected to a set of non-conducting diodes. During the next half-cycle, the upper bridge is conducting, and the lower transformer winding passes current through the load. During this half-cycle, polarity of all windings is reversed, however, and thus a *positive* half-cycle of output is produced as before.

Thus, positive-going full-wave rectified output is obtained for the conditions assumed. If, however, signal input were reversed in polarity, negative output would be obtained. If the ac signal input is only a few degrees out of phase with the reference voltage, a smaller output voltage would be obtained, until at 90° phase difference, output voltage consists of ripple only with no d-c component.

Output is insensitive to *reference voltage* amplitude (provided it is high enough) as the reference voltage has only a gating function. Output is directly proportional to input amplitude and to the cosine of input phase angle of the input. Thus, for phase measurement, the signal amplitude must be either held constant or taken into account.

Input impedance with a 1:1 ratio input transformer is approximately equal to the load impedance. If output load resistor is reduced to 20K ohms from the 150K ohms shown, output is reduced from ± 50 v by about 10%. The circuit is normally driven from a low impedance source; i.e. a cathode follower.

Frequency response depends on the transformers used; excluding the transformers, circuit may be used from 0 to 5000 cps. Performance is maintained at ambient temperatures to 125°C.

As in other circuits depending on balance of components, there is some residual output (± 0.5 v) for zero input voltage. A push-pull output may be obtained by center-tapping the output load resistor.

The Phase Comparator can be used to measure the phase relationship between two voltages. It provides a convenient conversion unit for control systems where ac sensing devices are used to operate dc control loops, or where a polarized voltage is necessary in order to show sense of direction. For example, an ac rate gyroscope gives an ac output voltage proportional to rate of turn regardless of direction of turn. To determine the direction of turn, the gyro output must be phase-detected to give a polarized dc voltage output.

Maximum output voltage: ±50 v dc.
Input voltage: 0 to 50 v ac.
Frequency response: 0 to 5000 cps.
Circuit load resistance: Approximately equal to applied load resistance.
Residual output with zero input: Less than 0.5 v.
Conversion efficiency: 85%.
Maximum ambient temperature: 125°C.
Source: Sanders Associates, Nashua, N. H.

CIRCUITRY

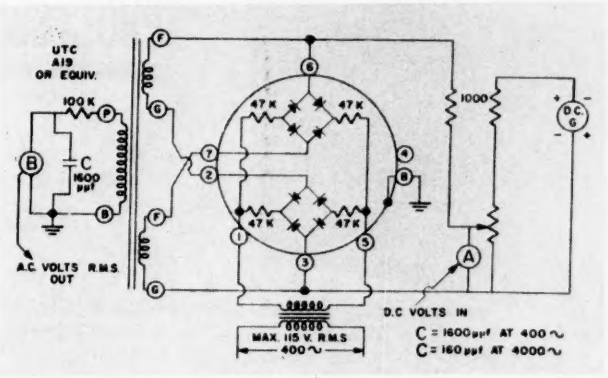
The circuit is the heart of all electronics. Here are 3 more basic and interesting circuits. Unless marked, resistors are in ohms, capacitors in microfarads.

MODULATOR CONVERTS DC TO AC

Action of the preceding circuit can be reversed to convert a dc signal to ac. Output is proportional to input for dc inputs up to 40 v, and reverses phase when polarity of input is negative.

Input is applied at the output terminals of the preceding circuit, via a 1K ohm series resistor. The same switching action of the diodes by the reference voltage causes the input signal to pass current alternately through the two bridges and the transformer windings connected to them.

With an input from a constant dc source turned on-and-off by the switching action of the diodes, the output waveform would be a square wave if it were not for the filtering action of the output transformer and the RC network on the output, which remove the higher frequency components. Capacitor C is 1600 $\mu\mu$f for 400-cps output frequency. At higher carrier frequencies, C is proportionately reduced to maintain the same impedance. For example at 4000-cps carrier frequency, C is thus reduced to 160 $\mu\mu$f, keeping the same filtering action without reducing output or shifting carrier phase.



Modulating applications use a fairly high level (500 mv) low impedance variable dc input from potentiometers, thermistors, or other voltage generating devices and convert it to ac to drive servo control motors or for other control purposes. Peak ac output voltage is equal to the dc input voltage for no-load.

Input: 0 to $\pm$ 40 v dc.

Output: 0 to 40 v pk ac at reference frequency.

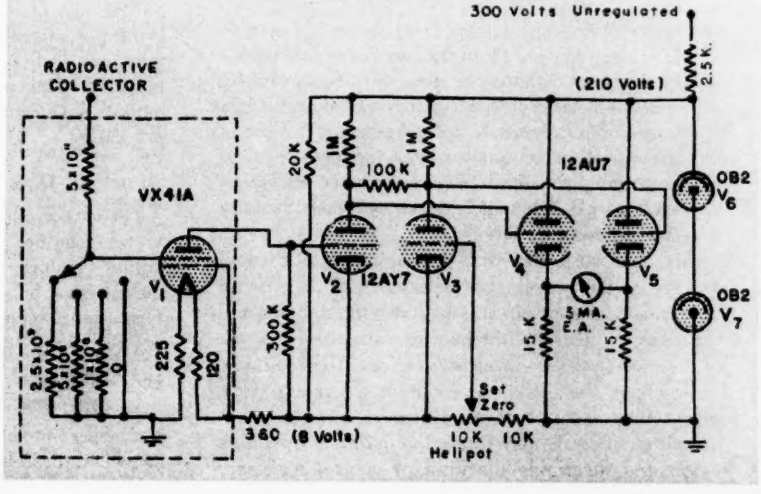
Source: Sanders Associates, Inc., Nashua, N. H.

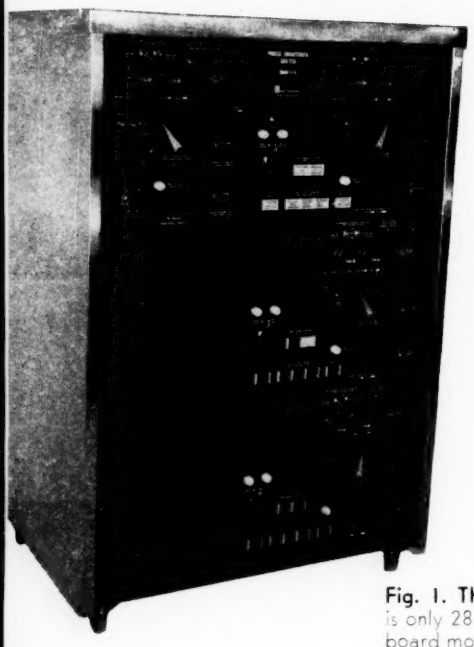
ELECTROMETER HAS INPUT IMPEDANCE ABOVE 10^{11} OHMS

Very high input-impedance is required of this vacuum-tube voltmeter, as the impedance of the radioactive collector whose potential is to be measured is about 10^{10} ohms. Used in atmospheric electricity measurements, this circuit drives a recording milliameter.

V1 is a special electrometer tetrode (VX41A) providing extremely high input impedance and about unity gain. Plate supply potential for VX41A is 8 volts; filament current is 10 ma. Voltage amplifier V2 drives the cathode-follower current amplifier V4; V3 and V5 were added to cancel drifts from heater voltage variation of V2. Current output is sufficient to drive a 5-ma chart recorder movement.

Source: G F Schilling, L G Smith, et al, "Modern Instruments for Atmospheric-Electric Measurements," *Scientific Report No. 5, University of California Institute of Geophysics.*





Exclusive Disclosure!

PROCESS CHARACTERISTIC ANALYZER

Fig. 1. THE PROCESS CHARACTERISTIC ANALYZER is only 28" wide by 24" deep and 43" high. The plotting board mounts on top.

MUCH has been written about the possibilities and wide applications of computer control and systems engineering in the process industries. However, little is known about the characteristics of the processes being talked about. Without such knowledge, talk of computer control or systems engineering is just that—talk.

Before much headway can be made toward even a beginning in computer control and systems engineering it is necessary to ask a few basic questions:

1. Will the computer operate from equations describing the process, or can it deduce where the process is operating and maintain optimal conditions?
2. Is enough known about the process to intelligently apply a computer of any type? For example, can the process output (quality) be described in terms of a pressure-temperature plane? What is the variation of quality over the pressure-temperature plane with respect to other variables, such as pH, or to side reactants, such as catalysts or solvents flow?

This disclosure concerns an equipment for rapid analysis of the process characteristics as they affect the problem of control. This includes the number and relationships between the major variables, and the location of optimal operating regions (determining, for example, the effects of input mix, contaminants, solvent flow, catalyst degeneration, etc.)

Such an analysis may locate the optimum operating region and determine the kind of control necessary to hold this condition through all variations that may occur.

In process characteristic analysis, it is necessary to choose allowable variations in a small number of variables, and program these so that an intelligible picture is obtained of the process reaction to these changes. A Process Characteristic Analyzer has been designed to perform this task automatically.

The Process Characteristic Analyzer (Fig. 1) is designed specifically for facilitating this study of *operating* chemical processes. The variables of the process are programmed automatically through controlled changes within predetermined limits to prevent upset. Within its limits a variable can be programmed in any number of discrete steps so that a full knowledge of the process characteristic curves is obtained. Where two input variables are involved, the changes are programmed so that all combinations are recorded. Output data is taken in analog form, but both input and output data can be recorded digitally for further processing.

How to Make An Analysis

Let us consider a process whose characteristic involves relations between pressure, temperature, and output product quality. The following process information must be set into the analyzer to plot a pressure-temperature plane (a plot of output quality at all given pressures and temperatures):

1. Upper and lower limits allowed for pressure and temperature.
2. Size of incremental steps for pressure and temperature changes, to be imposed by analyzer.
3. Time for process to stabilize after a change is made in the input (dead time or process lag).

BYRON WHITE
Quarie Controllers

Systems engineering, computer control, optimation, and process analysis by simulation all depend on knowledge of the process characteristics. Here is the first PROCESS CHARACTERISTIC ANALYZER, an instrument for automatically programming and plotting the inter-relationship of process variables.

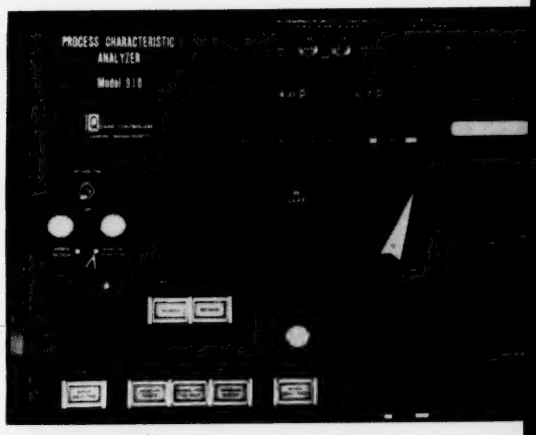


FIG. 2. THIS PANEL programs one variable; similar sections control additional variable simultaneously.

To facilitate setting the variable limits, the upper and lower limits of each variable are set individually on the control panel: readings are directly in millivolts either ac or dc, with a phase control for a-c signals so that any electric transducer can be used. A single-variable panel is shown in Fig. 2.

The Analyzer then takes each variable through its programmed steps until all combinations are tried and the resultant output recorded. It steps the variable by changing the set point. A motor-driven air regulator (which is available with the instrument) can be used to drive pneumatic valves directly.

The Analysis Action

The limits within which each process input is allowed to change are independently set into dials on the Analyzer. A setting also is made which establishes the size of the discrete steps desired.

Fig. 3 illustrates a program for a single-variable problem: this is a plot of the process input variable set-point versus time. (Note that this is not the actual value of the input, but the set point.) The following definitions of the labeled portions of the step functions will clarify the action:

"S" is the preset size of the discrete step in the process input variable that will be imposed by the Analyzer.

"M" is the total change in process input set-point representing the sum of discrete changes of preset size "S" which comes closest to filling (without exceeding) the allowable limits of excursion of the variable as set in the Analyzer.

"T" is the time required for the process to stabilize after the discrete step "S" has been made. During the time "T" two things happen in the process: First, the new input condition called for by the set point step-change "S" is reached and stabilized; then the process output stabilizes as a result of that new value of process input. Just prior to the next step change "S," at the end of "T," the Analyzer automatically reads out all values of input and output, with individual command printout signals if required.

"R" illustrates the action of the Analyzer when the allowed limit of the process input variable is reached by step change S. (At some time the analyzer will call for a step change S which will command the process input to exceed the preset allowable limit.) As the process responds to the called-for-change, the *actual* process input (such as actual temperature) will reach the preset limit and the Analyzer responds by returning the set point to its last value. Simultaneously, it reverses the direction of all future changes in process input and then waits for a time equal to the stabilization time "T" before proceeding with any action. Thus the Analyzer can be set to cycle automatically between the preset limits.

If the actual value of process input was very close to the preset limit at the time of the change, then the reversal action will take place almost immediately, and the width of the reversing segment "R" will be very narrow; its maximum width (time) will be when a change in process input set-point just exceeds the preset limit.

"W" is an additional time delay between analysis cycles, which can be set to any desired value including zero. This time delay can be used for changing recording paper, or for changing other variables by hand. The "W" timer also checks that the remainder of the circuit is operating properly.

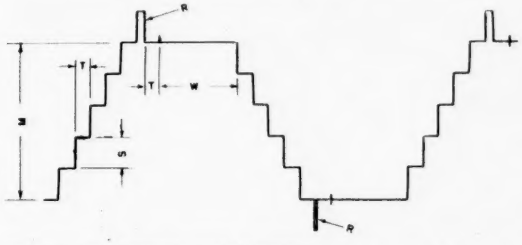


FIG. 3. DISCRETE CHANGES in input variable set-point are shown plotted against time.

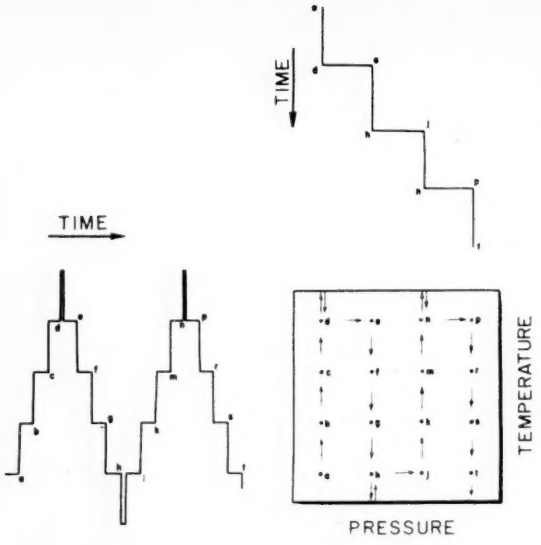


FIG. 4. ANALYZER automatically programs four different pressures and four different temperatures (the pressure-temperature plane) over all possible combinations (16) in the order indicated by the arrows drawn on the X-Y plotting board. First operation is to step the temperature through steps a, b, c, d, while pressure is held constant. Output (product quality) is recorded at each point. When temperature limit is reached, the **pressure** is changed one step (to e) and 4 temperature changes are again imposed in the other direction at this new pressure. Note that pressure increases one step only when temperature reaches a high or low limit and reverses. Process output (quality) is recorded at each point.

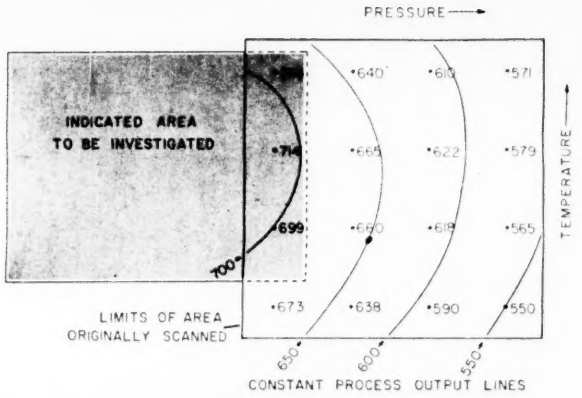


Fig. 5. NUMBERS REPRESENT output of the process (quality, for example) as a function of pressure and temperature. Sketching in the lines of constant output reveals a possible area of interest (shaded portion) that should be investigated as a possible area for optimum operation.

Multiple Variables

The basic sequencing of single variables can be combined to encompass two or more variables. A second process input variable would be changed one incremental step each time the initial process input variable reaches a limit and reverses (R in Fig. 3). Likewise, a third input variable would change one incremental step each time the second variable reverses. At the end of each process stabilization time (T) the actual values of all input and output variables are recorded. Thus all possible combinations are recorded in a logical order.

This procedure is illustrated for a two-dimensional case in Fig. 4. Note that the full range of the allowed changes in temperature is covered four times for the single range of pressure changes. The small arrows on the pressure-temperature plane show the cycling sequence in this plane and illustrate the reversing action of the temperature input control.

The successive steps involved in the analysis of a typical problem illustrate the use of this new instrument and concept. In the following example, process outputs are represented by relative numbers; these numbers could represent any property of the output pertinent to the problem—quality, total product, time required for reaction, etc.

Self Programming Analysis

Assume that the process inputs are pressure and temperature and that these inputs are to be programmed within a limited range around their nominal set-points. Within this range the Process Characteristic Analyzer is set to program four discrete changes of the two input variables. The sixteen combinations are programmed automatically and the resultant output recorded on a chart as shown in Fig. 5. The numbers beside each dot are the relative output readings for each of the combinations of pressure and temperature (indicated by relationship of the dots to the x-y coordinates).

The curved lines are drawn in to connect constant process output; these are like the isobars on a weather map.

The curve of these equal-output lines shown in Fig. 5 point up the probability of an area that might yield better output—the area lying in the same temperature zone but at lower pressures to left of the plot. The Analyzer can investigate this area by making the following changes in its limit settings:

(1) Lower the high temperature limit slightly.

(2) Raise the low-temperature limit.

(3) Change the size of the discrete step so that four recorded steps are still made in the narrowed limits.

(4) Lower the low-pressure limit by an amount approximately equal to the previous span.

(5) Lower the high-pressure limit to a point just above the previous low limit.

(6) Set the size of the discrete changes in pressure so that five recorded steps are made over the new span.

There are now a total of 4 x 5, or 20, possible combinations to be recorded in the pressure-temperature plane with the new settings. A typical result is shown in Fig. 6. The lines of constant output indicate a

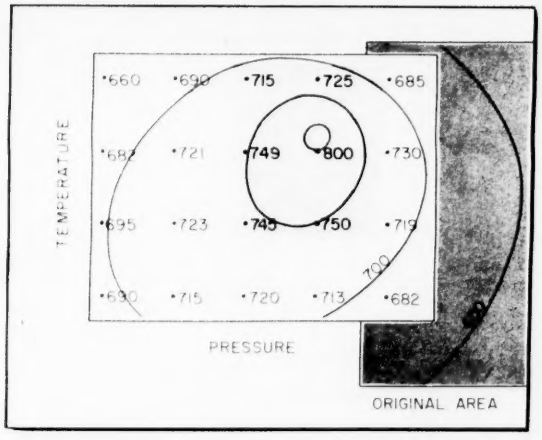


FIG. 6. ANALYSIS of the new area reveals an optimal condition of pressure and temperature. The optimal area worth closer study is indicated by the light shading.

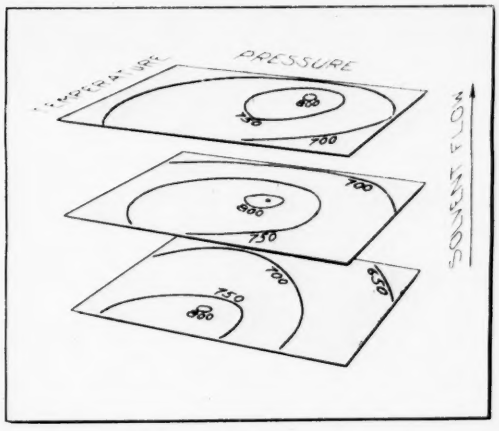


FIG. 7. THE ADDITION of a third variable shows a maximal condition existing within the values chosen for all three process input variables.

maximum, and the area indicated in a light shade would now be interesting to examine more closely. It is possible to close in on this area and examine it with a fine grid in the same manner.

We have now obtained a considerable amount of useful data. The optimal pressure and temperature are known, as well as the accuracy of control necessary for an allowable change in output. The effect of incremental increases and decreases of pressure and temperature are readily determined, and we have valuable knowledge of the system output *in this pressure-temperature plane*. This is the type of data necessary for simulation of the process, or computer control of the equation type.

Of course there are other factors that can cloud the picture. For example, we still do not know the effect on this area of a change in other variables—perhaps input mix, catalyst activity, or solvent flow; also what is the effect of unexpected contaminants, and does the process return to this identical plane configuration after a major upset? These questions also must be answered prior to simulation of the process or control by equations. Rather than make a close exploration of the lightly shaded optimal area of Fig. 6, it would probably be more useful to explore a third variable, say solvent flow.

Study by Function Planes

The settings made for obtaining the grid of Fig. 6 are retained because they should provide enough range around the optimum region to allow for expected deviations. A third variable, perhaps solvent-flow, is given three values within predetermined limits and programmed automatically by the Analyzer. Now there are three pressure-temperature planes plotted, each for a different value for solvent flow. After the output values are recorded automatically beside each point, the constant-output lines are drawn in for each plane and the pressure-temperature planes are stacked in the order of the three values used for solvent-flow (Fig. 7). The top plane is the same as Fig. 6.

A study of Fig. 7 indicates a definite dependence on solvent flow, although it is not as sharply defined as is the case for pressure and temperature. Note that the "800" constant-output line encompasses a greater area in the center plane and less in the top and the bottom planes; thus optimal solvent flow is at or near the value assumed for it in the center plane.

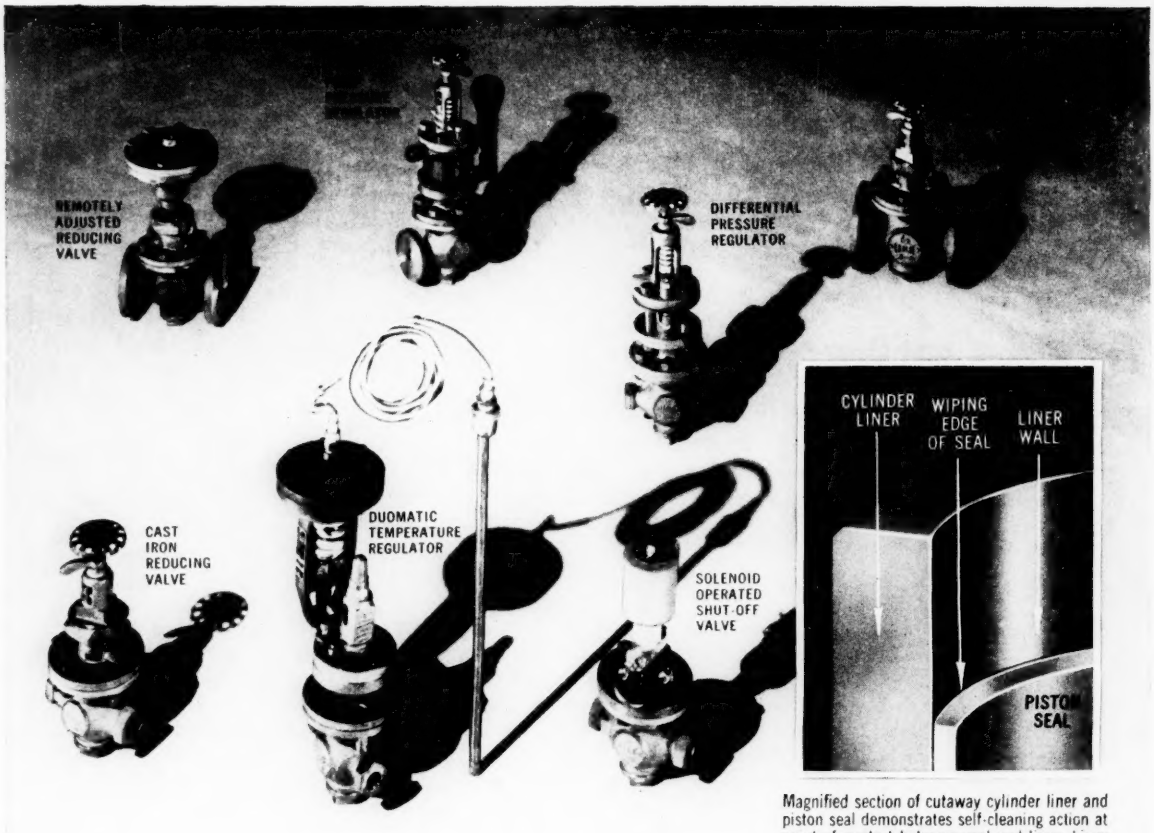
Note also that as solvent flow changes, the optimum points on the pressure-temperature plane change. Thus, to maintain optimal conditions, it is necessary to use an optimal control method for each of the three variables. For instance, if the reaction is such that the solvent becomes partially used or diluted by the reaction, the location of its maximum will shift with the activity of the process. The optimal condition can be maintained with a control that adjusts the solvent flow to maintain maximum output, or a control that makes up the solvent strength as a function of the maximum and maintains constant flow.

The effects of more subtle variables also can be determined readily. The simplest way would be to hold pressure, temperature, and solvent flow at the values found to be optimal and program another variable, such as viscosity or pH, through a range of values as a single-variable problem, and note the results. However, much more information will be gained by going through the same procedure as used for the solvent-flow analysis shown in Fig. 7—that is, program variations in all variables, within limits, so that the inter-relationships are revealed.

The Process Characteristic Analyzer can program up to *five variables* simultaneously.

Optimal Control

An extension of the same principle makes it possible to control the process at any given slope of any given characteristic—resulting in optimal control. But before optimal control can be proved practical for any given process it is desirable, if not necessary, to analyze the process characteristic. This now can be done rapidly and economically.



Magnified section of cutaway cylinder liner and piston seal demonstrates self-cleaning action at point of contact between seal and liner. Liner wall is swept clean of contamination deposits.

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Vacuum--Regulators, Pump Governors, Breakers, and Relief Valves

Vacuum regulation as a special case of pressure regulation requires a special type of regulator. The seventeen pictures of this chapter illustrate a variety of equipments classified under the headings of vacuum regulators, manostats, vacuum pump governors, vacuum breakers, and vacuum relief valves.

FRED D. MARTON
Instruments & Automation

CHESTER S. BEARD
General Controls Co.

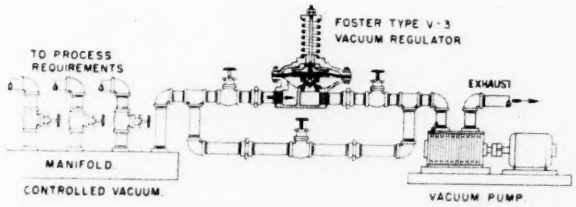
VACUUM regulation is essential in many industrial processes, for chlorine dispensers, and in food canning. In Chapter 3 we touched on the subject of vacuum regulators, and classified them as a special type of back-pressure regulators because vacuum is a positive pressure when referred to absolute zero pressure.

Vacuum regulators usually reduce a high vacuum to a lower vacuum which is to be maintained in a vacuum collecting system at a constant value. Thus the vacuum pump (or other means of creating a vacuum) is connected to the outlet side of the regulator, and the gas well (or other vacuum collecting system) is connected to the inlet side, as shown in Fig. 10-1. The flow is from the low, or controlled vacuum side, to the suction or high-vacuum side. Note that the only difference between vacuum regulators of the types shown and conventional back-pressure regulators is the large-size diaphragm required because of the low pressure (suction) ranges. One type of vacuum regulator (Fig. 10-2) is equipped with swing-link yoke and balanced lever so that it can be mounted with the diaphragm either above or below the pipe line (upside down).

A typical spring-loaded, diaphragm-actuated, double-seated type is shown in Fig. 10-3. It is made with screwed connections up to and including the 2" size, and with flanged connections up to 6". The large diaphragm and absence of stuffing boxes and dash pots secure high sensitivity. This type finds application mainly in sugar refinery evaporators, dairy milking machines, cookers, and photographic printing frames.

The regulator shown in Fig. 10-4 is designed for moist chlorine service in a chlorinator unit. Moist chlorine gas is one of the most corrosive of all chemicals so that special materials have to be used. Four functions are combined in one body: The lower part is the *vacuum regulator:* the upper part regulates *differential pressure:* part "C" (between the two diaphragm chambers) is a vacuum breaker; and part "B" serves

Fig. 10-1. Flow through a regulator in a vacuum-reducing circuit is from the collecting system to the pump.



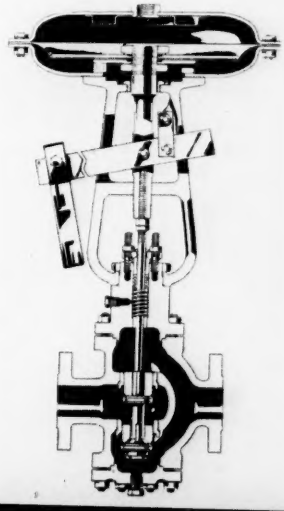
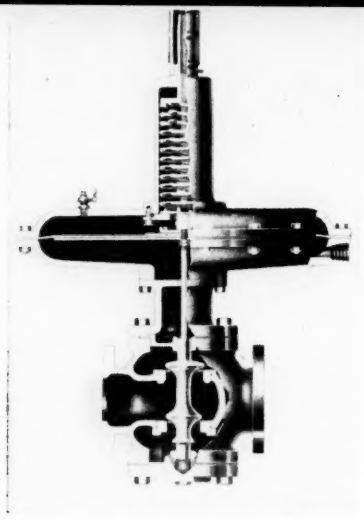


Fig. 10-2. Lever-and-weight type regulator can be mounted upside down.



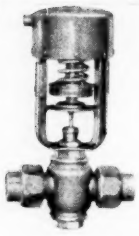


Fig. 10-6. Packless type regulator avoids contamination in the food-packing industry.

Fig. 10-3. Spring-loaded diaphragm type is characterized by large diaphragm chamber.

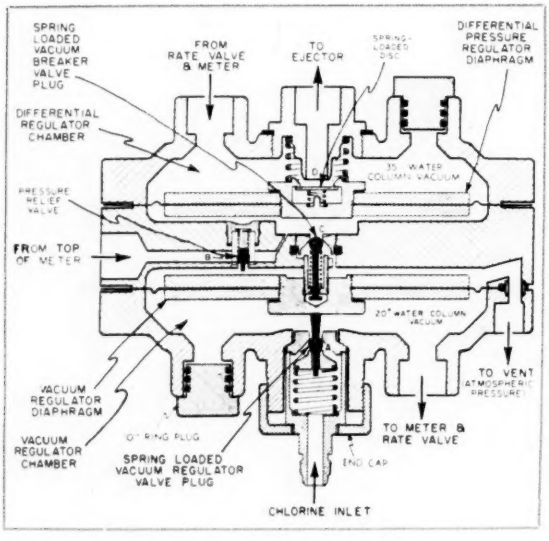


Fig. 10-4. Combination regulator for moist-chlorine service requires all-corrosion-resistant construction.

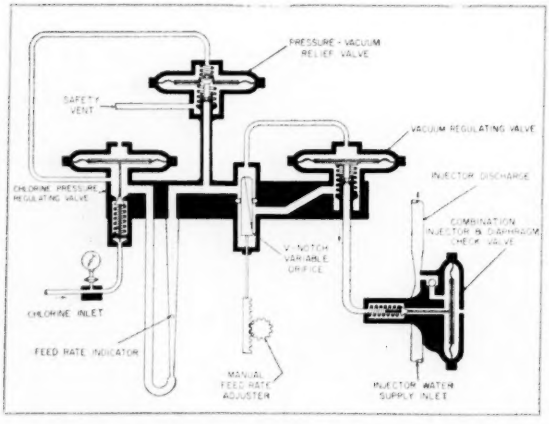


Fig. 10-5. Separate valve units in chlorinator circuit afford interchangeability.

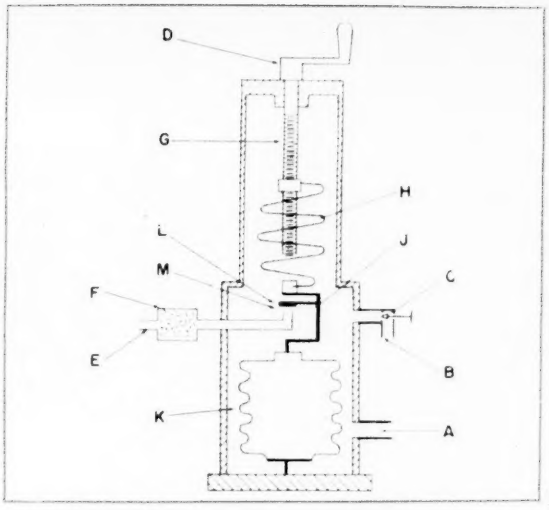


Fig. 10-7. Aneroid manostat is a suitable device for vacuum regulation.

for pressure relief as an additional safety feature. The body of the chlorine regulator is made of Uscolite, a plastic which is suited for the service, valve stem and plugs are made of tantalum, springs are of Hastalloy "C," valve seats are of Teflon, and the diaphragms are made of Kel-F.

Another chlorinator circuit is shown in Fig. 10-5. Three separate valves are used with cartridge-type inserts to adapt the units for their individual control function, thus affording interchangeability. The chlorine pressure-reducing valve at left maintains the proper operating vacuum developed by an aspirator-type injector, and shuts the chlorine supply down when the vacuum is lost. The vacuum regulating valve at right secures a constant differential pressure across the V-notch variable-orifice flowmeter; and the pressure-vacuum relief valve vents to atmosphere, and relieves any excess vacuum which can occur, as for instance, when the chlorine supply is exhausted.

The regulator illustrated in Fig. 10-6 is of the packless type, incorporating a bellows. It is mainly used in the canning industry.

Manostats

The aneroid manostat (Fig. 10-7) is a suitable regulator for accurate control of vacuum apparatus. The controlled system is connected to "A," and the source of vacuum to "B." Inlet "E" is left open to atmosphere. Adjustment is made by turning crank "D" which, in turn, positions valve disc "L" over port "M." If either pumping rate of the vacuum source or atmospheric pressure changes, expansion or contraction of the bellows restores equilibrium.

The manostat (Figs. 10-8a and b) also is a precision vacuum regulator. It uses the Cartesian-diver principle for accurate vacuum regulation. The sensing element is an inverted can floating in an annular pool of mercury. A three-way valve equalizes the vacuum above and below the float. When the valve is closed,

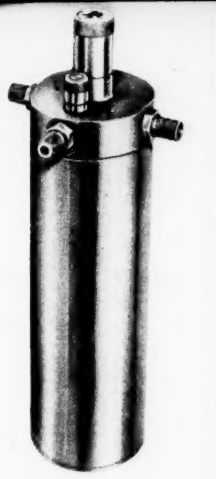


Fig. 10-8. High sensitivity of vacuum regulation is achieved with Cartesian-diver type manostat.

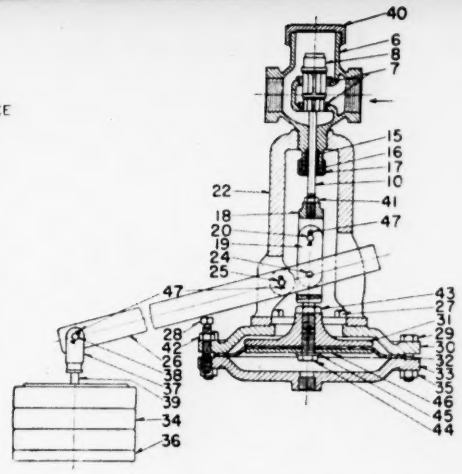


Fig. 10-9. Vacuum pump governors maintain a constant vacuum or suction on the return to the pump.

the volume under the float is sealed off. When a pressure change occurs above the float, the balanced orifice will open (or close) to maintain the pressure. Use of a balanced orifice (as in balanced valves) assures high flow capacity with sensitivity. An added feature are "memory seals" in the form of O-rings which seal the unit when the float reaches its lowest position, trapping the pressure under the float with a positive action. Thus when the unit is shut down it "remembers" its setting. Industrial applications of the Cartesian manostat include filling of vacuum tubes with specific gases.

Vacuum Pump Governors

In steam heating systems it is often required to maintain a constant vacuum or suction on the return to the pump to obtain maximum head efficiency. A governor of the type shown in Fig. 10-9, installed in the steam line to a steam-driven reciprocating or rotary vacuum pump, will keep constant suction. For low vacuum the valve is equipped with a differential lever.

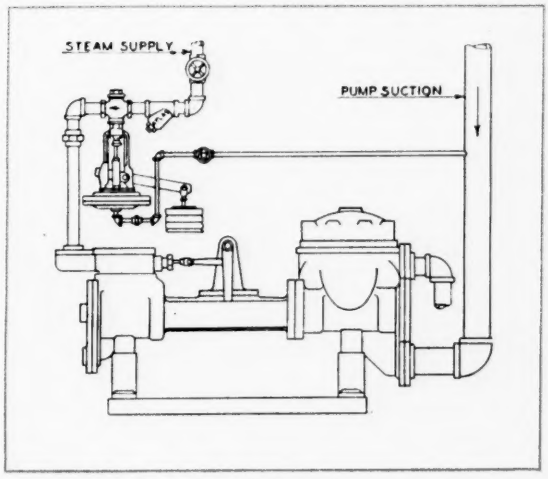


Fig. 10-10. Typical installation of vacuum pump governor.

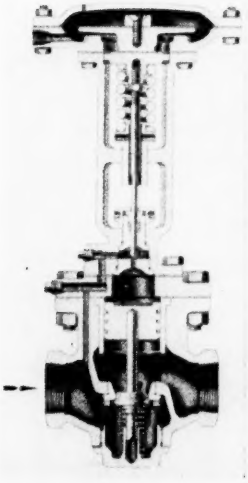


Fig. 10-11. Sensitive control for steam-driven vacuum pumps is achieved with pilot-actuated governor.

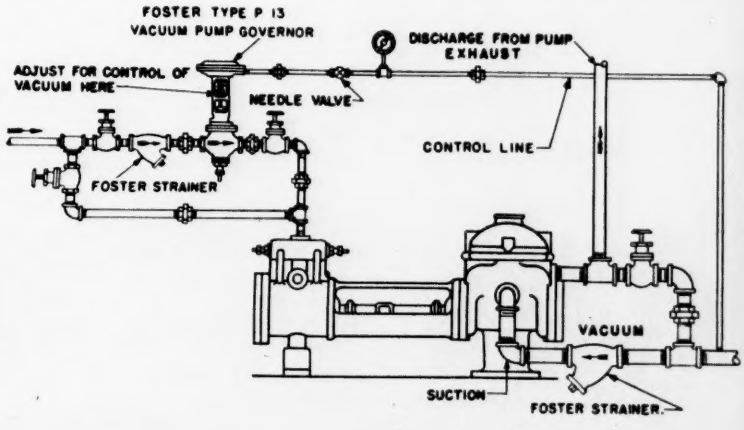


Fig. 10-12. Typical circuit for a vacuum pump governor.

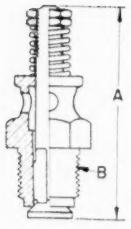


Fig. 10-13. Vacuum breakers can be made in simple construction.

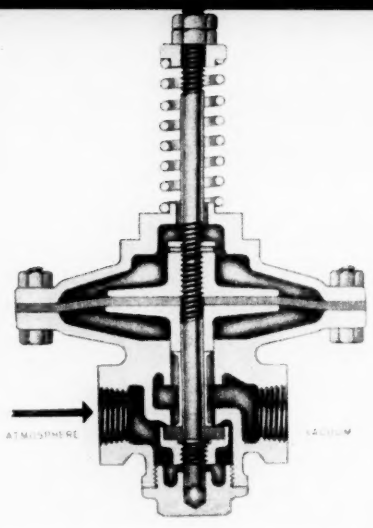


Fig. 10-14. Vacuum breakers with diaphragm actuation give higher sensitivity.

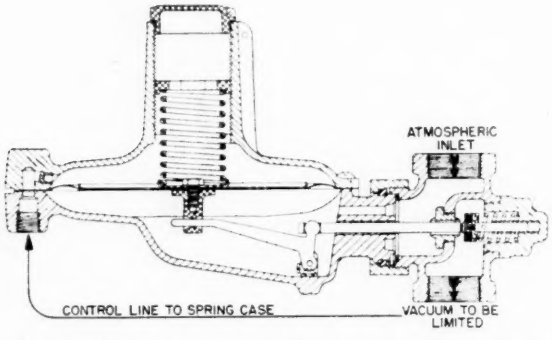


Fig. 10-15. This vacuum breaker is an offspring of the domestic gas-regulator.

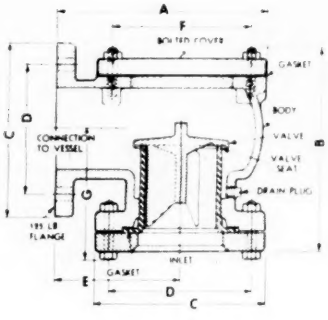


Fig. 10-16. Vacuum relief valves are usually made in large sizes (3" to 6").

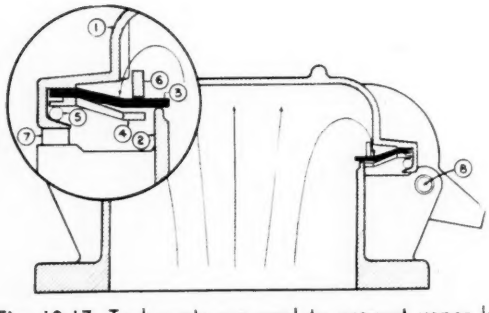


Fig. 10-17. Tank vents are used to prevent vapor loss within the maximum vacuum limits of storage tanks.

High-vacuum service requires a lever with a heavy weight. Various vacuum conditions can be handled with different sizes of diaphragms, down to 28" Hg. The inner valve is balanced and of the quick-opening type. Fig. 10-10 shows an installation diagram for a vacuum pump governor.

Fig. 10-11 illustrates a pilot-actuated piston-type vacuum pump governor. Installation in the steam line to the engine (Fig. 10-12) regulates the steam supply by opening or closing the valve according to impulses which the diaphragm assembly receives from the suction line. The large controlling area (which is the difference between the diaphragm in the chamber and the diaphragm between the chamber and the yoke) provides high control sensitivity.

Vacuum Breakers and Vacuum Relief Valves

As the name implies, vacuum breakers serve the purpose of breaking a vacuum when it gets too high. This is done by admitting enough atmospheric air to the vacuum system under control to reduce the vacuum to safe limits, after which action the vacuum breaker closes. One such use is to prevent steam shells and hot-water shells from collapsing when they cool down after use of the equipment, or to prevent damage to closed vessels such as boilers, reactors, stills, and retorts where a vacuum build-up may occur. Thus vacuum breakers are actuated by atmospheric air at a setting controlled by an adjustable spring (Fig. 10-13). Greater sensitivity is provided by diaphragm actuation where the differential created across the diaphragm overcomes the spring setting (Fig. 10-14).

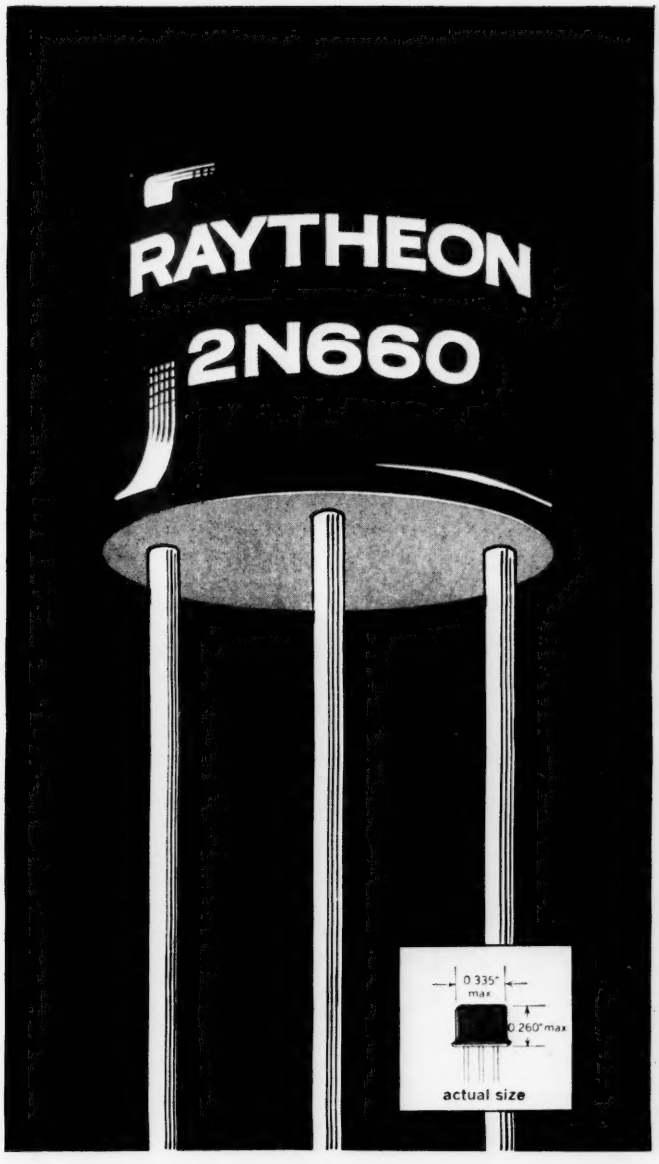
The vacuum breaker shown in Fig. 10-15 is an offspring of the domestic regulator described previously (Chapter 6). It has a large diaphragm and a lever system extending into a fitting which is attached to the side of the diaphragm chamber. A union connection permits the body to be rotated with respect to the gas line. To limit the vacuum the outlet must be piped into the spring case. The same type may be used as a vacuum relief valve, in which event the outlet is left open to the atmosphere. (Refer also to Fig. 10-4.)

Vacuum relief was discussed briefly in Chapter 8 (a combination pressure-vacuum relief type was shown in Fig. 8-14). *Relief* units are also made for relieving vacuum only (Fig. 10-16).

Tank vents (Fig. 10-17) are usually made for pressure-and-vacuum combinations and serve the purpose of preventing vapor loss within the pressure and vacuum limits of storage tanks. When vacuum is applied to the tank, atmospheric pressure lifts diaphragm 3 from its seat and in-breathing takes place through the grid opening in retaining ring 4. Vacuum ring 6 prevents in-breathing until the vacuum opening pressure is reached.

Acknowledgement

Figs. 10-1, -11, -12, and -14 are by courtesy of Foster Engineering Co.; Fig. 10-2 and -15 Fisher Governor Co.; Fig. 10-3 Mason-Neilan; Fig. 10-4 Fischer & Porter Co.; Fig. 10-5 and -7 Wallace & Tiernan Inc.; Fig. 10-6 Fulton Sylphon Div.; Fig. 10-8 Hoke-Manostat Corp.; Figs. 10-9 and -10 Atlas Valve Co.; Fig. 10 -13 Alcor Valve Specialties Co.; Fig. 10-16 Johnston & Jennings Co.; Fig. 10-17 Black, Sivalls & Bryson, Inc.



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2N659	−20	10	70	55	2.5	65	12
2N660	−16	15	90	65	2.5	70	12
2N661	−12	20	120	75	2.5	75	12
2N662	−16	8	25 min.	50	2.5	65	12

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Boiler Drum Level Control

This description of boiler feedwater control from single element through compensated three-element control parallels the historical development of improved control.

A. WAXMAN

Hagan Chemicals & Controls, Inc.

PRIMARY FUNCTION of any feedwater system is to supply water to the boiler steam drum to maintain the drum level at a safe height above the tubes, and yet sufficiently below the take-off connection (header) on top of the drum to prevent water carryover into the steam.

Feedwater flow to the boiler can be controlled (1) by a control valve located between the pump and the steam drum, (2) by varying the delivery of the pump, or (3) by a combination of both. All of these methods are now in use in modern plants.

A constant pressure upstream of the control valve is required sometimes and can be maintained by varying pump speed with a suitable fluid or electric coupling or other speed adjustment system such as a turbo drive.

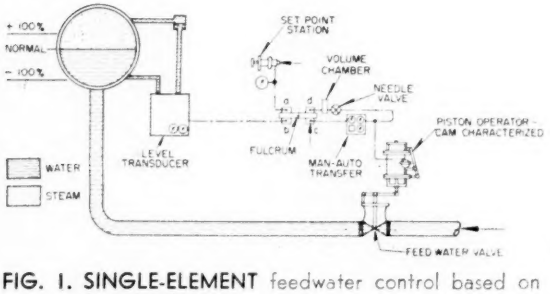


FIG. 1. SINGLE-ELEMENT feedwater control based on drum level.

June Meeting: Thursday, the 19th, Villa Marina Restaurant, Balboa, California.

Feature: Tour of the new Huntington Beach Power Station of the Southern California Edison Company.

Single-Element Systems

Fig. 1 illustrates a single-element system. Here the level of the water in the steam drum is controlled to a set point. The controller mechanism, or regulator, shown is a *ratio totalizer* (Fig. 2). The ratio totalizer is a general-purpose control unit that can give proportional, integral and rate actions, and also perform addition, subtraction, multiplication, and ratio actions

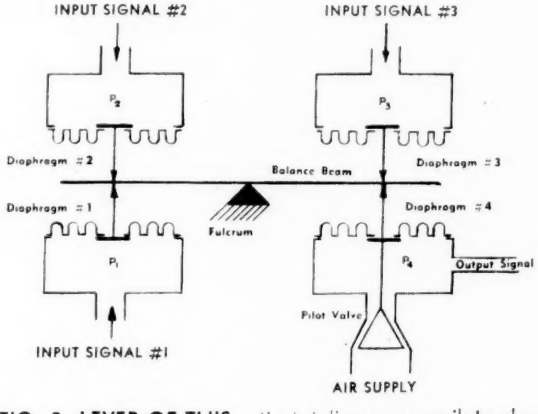


FIG. 2. LEVER OF THIS ratio totalizer moves pilot valve when forces are out of balance. Set point is usually brought to #2 and signal to #1 to perform basic comparison. Fulcrum can be moved to change gain.

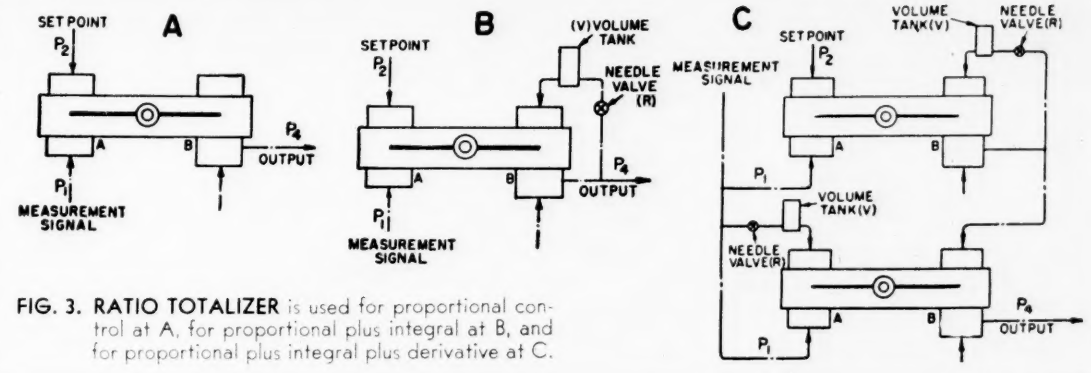


FIG. 3. RATIO TOTALIZER is used for proportional control at A, for proportional plus integral at B, and for proportional plus integral plus derivative at C.

as required. Hence it is both a control and a computer element.

The ratio totalizer is a force-balance unit in which a non-bleed pilot valve controlling the output air pressure serves as the balance device for the four nometallic diaphragms arranged in opposing pairs. The two elements of each pair are attached to a common post: a beam, rotating about a fulcrum, is connected between the two posts.

The resultant force up or down at the left post, when multiplied by its distance to the fulcrum, always must equal the resultant force at the right-hand post multiplied by its distance to the fulcrum. Hence moving the fulcrum to the right increases the effect of inputs 1 and 2 on the output; moving it to the left has the opposite effect.

Some of the various possible actions are shown in Fig. 3. In A the difference between set point and measured signal yields a proportional-action output signal. In Fig. 3(B) integral action is added to the proportional controller; this application is a clear illustration of the integral action of most pneumatic controllers. Similarly, the way rate action is added in Fig. 3(C) is applicable to most pneumatic controllers.

Variations in drum level (see Fig. 1) are sensed by the level transducer and brought to chamber "b" and upset the balance between chambers "a" and "b." This pressure difference is multiplied by the gain of the regulator. The reset (integral action) is determined by the fixed capacitance of the volume chamber and the adjustable needle valve, establishing the reset time-constant for the controller.

The control valve is driven until a balance is attained between chambers "a" and "b" of the regulator. The set-point and feedback signals balance when the water in the drum is returned to the set point.

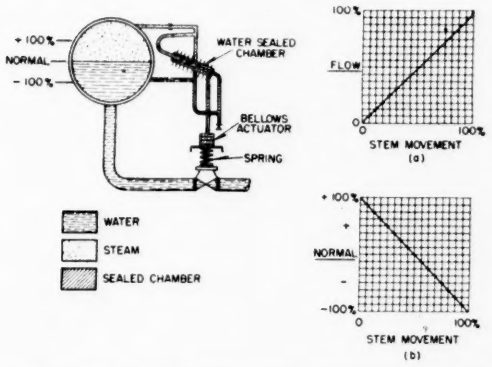


FIG. 4. CLOSE-COUPLED, thermo-hydraulic, single-element level control.

Thermo-Hydraulic Control

Fig. 4 shows a typical thermo-hydraulic single-element system. Its operation depends on changes in drum level, exposing more or less of the area surrounding the water-sealed chamber. Changes in temperatures affect the saturation pressure in the sealed volume of water, acting directly on the bellows actuator fixed to the valve stem. The proportional action is best explained by two simple graphs (a and b in Fig. 4).

Fig. 4(a) is found by assuming the valve to be so ported that the flow increases linearly with stem movement.

Fig. 4(b) can be derived on the assumption that the hydraulic pressure created in the bellows actuator will open and close the valve linearly with changes in level.

From a control standpoint, the system is proportional. Low drum levels generate greater hydraulic pressures (more exposed steam area) and result in greater feedwater flow; high level results in low flows. Thus, during a load "pickup" the drum level may be at the high point and the amount of "swell" that can be tolerated is limited.

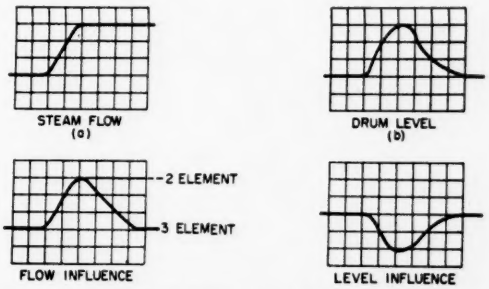


FIG. 5. TRANSIENTS FOLLOWING an increase in load.

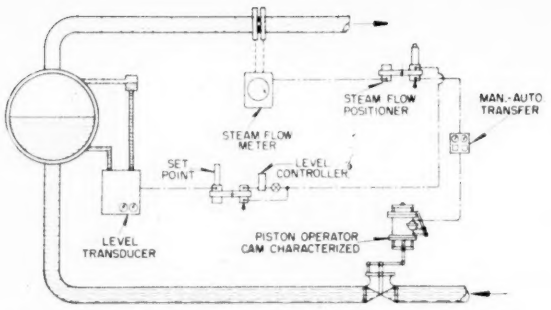


FIG. 6. TWO-ELEMENT (steam flow and level) control.

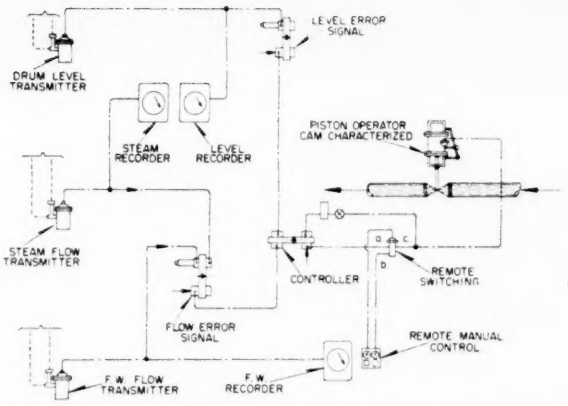


FIG. 7. THREE-ELEMENT control compares feedwater flow with steam flow, then compares this error signal with drum level.

Level Transients

Consider a boiler steaming at some preset rate with feedwater flow equivalent to the steam output plus rate of boiler blowdown. A load increase will lower the drum pressure and be accompanied by a flashing of water into steam. With a drop in steam drum pressure, the combustion control system will restore drum pressure by increasing the firing rate. The rate at which the increased heat release takes place in the furnace affects ebullition (boiling) in the tubes. Increased firing always increases the steam-bubble volume and creates a *swell*, which means that level is not a true representation of the pounds of boiling water available.

A sudden increase in load causes the level in the steam drum to follow the transient curve shown in Fig. 5(b), caused by the combined effect of flashing in the drum and the swelling effect of steam bubbles forming in the generating tubes.

The two transients shown in Fig. 5 (a and b) are the key influence in the control system design. The *rate* at which the steam flow changes will affect the shape of the drum-level transient. In a single-element drum-level control system, the level effect alone controls the feedwater valve and, hence, the amount of feedwater flowing into the drum.

The introduction of feedwater as a cooling medium tends to *reduce* level temporarily. The drawback to drum-level single-element control is that during swell the rising level tends to close the control valve when actually the reverse may be desired. However, steam flow can be used as a second element for control to counteract the level effect which is trying to close the valve. The combined effect results in constant feedwater flow during the transient. As the level returns to the set point, the level influence diminishes, allowing the steam flow effect to become dominant and feedwater flow increases to meet the new steam flow demand.

Two-Element Feedwater Control

Positioning the feedwater valve as a function of steam flow and superimposing the regulation of the level transducer constitutes typical two-element control and is shown in Fig. 6. In the two-element system, the second element is introduced in an attempt to offset the disadvantages of using only level.

Three-Element Feedwater Control

The next logical step is to measure feedwater flow and compare it to steam flow; the difference is intro-

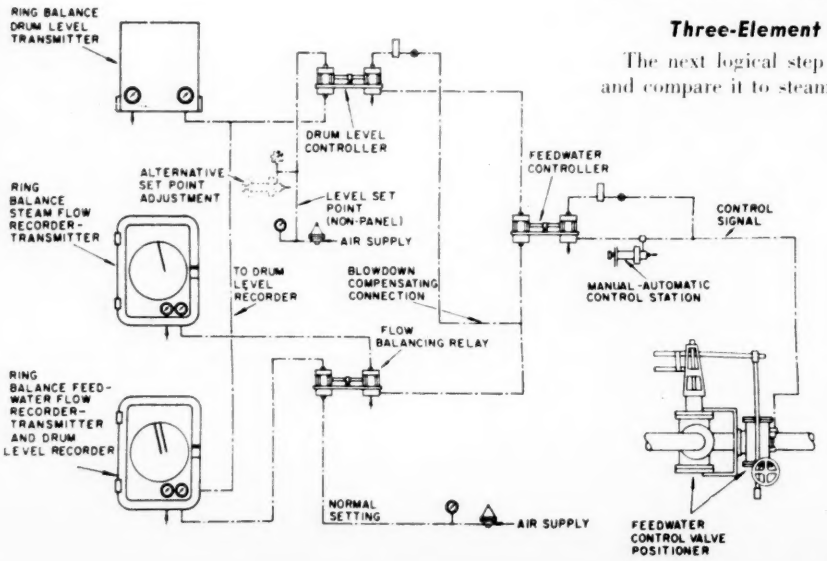


FIG. 8. BLOWDOWN-COMPENSATED feedwater control.

duced into the control system as an error signal. This is the primary signal in three-element systems (Fig. 7). Here the error signal between steam flow and water flow is compared to the error signal in level (deviation from set point). The net error signal then is applied to the controller regulating the feed valve. The computer (totalizer) with the greater gain has the greater effect on the feed valve. In most systems the flow error is given the gain advantage over the level error. Gain and reset action of the controller are adjusted to establish the proper transients.

One of the established types of three-element control systems includes compensation for boiler blowdown (Fig. 8). The level control signal is used only to trim the system to the drum level set point. Should the feedwater flow increase for reasons other than steam flow or level changes, the flow balancing relay acts to close the feed valve. Note that there has not been any change in steam flow, and any change in drum level would be returned to set point by the level controller. Thus, demands for feedwater other than for steaming are compensated automatically.

One further refinement is the addition of negative offset whereby the controlled level in the drum depends on load conditions. During low load the level in the drum is held low; a higher level is permitted during high load. Since swell is experienced in load pickups, maintaining water at a low level during periods of low load allows a more rapid pickup within safe operating ranges.

Level Compensation

Level indication deserves special consideration. Wherever level is measured, we must be sure that the level used for control represents the true level within the drum. The boiler operator must monitor by the drum-level gage irrespective of the type of control system made available to him. Radiation from the gage glass might cool the gage water to 300° F, resulting in an observed difference of 4". The important factor at any operating condition is the difference in level between drum and gage glass.

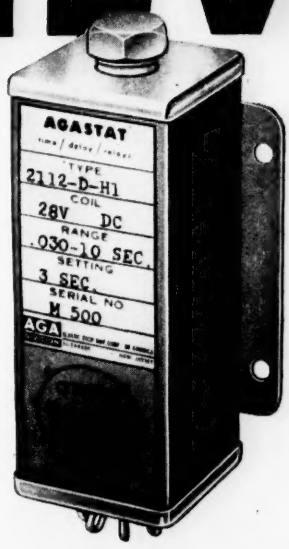
The basic problem in temperature compensation of level systems is one of using a transducer which measures a pressure difference (rather than level) and of converting the pressure difference into a level reading in inches of water referenced, usually, to the actual temperature in the boiler. Since head and pressure difference are related by density, automatic compensation of a meter is required when the boiler pressure (and thereby the density) varies. "Pressure" compensating columns can be used for stabilizing the compensation reference. However, accurate compensation must depend on pressure- or temperature-operated compensating mechanisms in the recorder.

The two generally-employed reference columns can be classified as follows:

1. Jacketed columns in which the reference leg and the moving leg are held at the same temperature.

2. Columns in which an ambient (room) temperature column reference is employed. The change in the density of water with temperature at room temperature is trivial. Therefore this simple column can be used with success.

NEW



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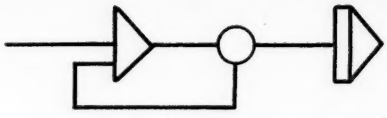

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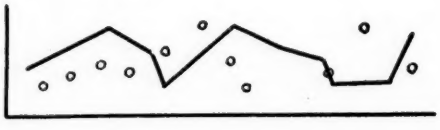

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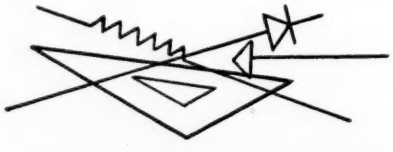

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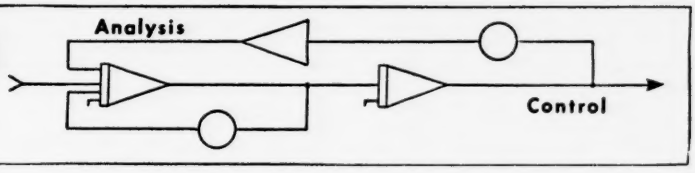

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Bits

This month a crazy mixed-up version* of the very informative meeting at Point Mugu, where speakers told not what they planned to do or hoped to do with flight tables in their simulation facilities, but described actual experiences with fact and—comment.

This, together with a few plugs under Info for things which I found interesting and which I thought you might.

Then a closing Thot which I am glad someone thunk.

Pieces

WESTERN S/C MEETING OF 13 MARCH ON "USE OF FLIGHT TABLES IN SIMULATION"

More than 90 representatives of at least 38 different organizations** gathered at the U. S. Naval Air Missile Test Center at Point Mugu, Calif. for a meeting of the Western Simulation Council on Thursday, 13 March 1958.

Just about 64 months earlier another much smaller group had met at the same place to found the original Simulation Council, model for the five other Councils subsequently organized in various areas of this country and Canada and now associated as the Simulation Councils, Inc. The Councils, and Simulation too, have come a long way since then in a sort of symbiotic relationship which has benefited both.

In the morning there was an interesting and well-organized (surprise!) tour of the test base followed by an inexpensive (again surprise!) and good luncheon in the Officers' Mess.

After lunch buses took us to the Station Theater where we were welcomed by the Director of Tests, *Captain C. H. S. Murphy*, whose remarks on the value of simulation, the good work of the Councils, and your Editor's personal contributions were erudite, cogent, and flattering—in that order.

Willard Uplinger (US NAMTC), who certainly deserves a "Well Done" for his part in arranging the meeting, was the first speaker on the subject of the day: "The Use and Usefulness of Flight Tables in Simulation."

However, for the benefit of readers who might not be familiar with flight tables I am going to change the order in this Newsletter and present first the comments of *R. W. Bond* (Autonetics, Downey, Calif.), the third speaker, as I believe they constitute a good introduction to the subject.

Bond on Precautions and Basic Applications of Flight-Table Use

In his opening remarks Mr. Bond called attention to the fact that Dr. A. C. Hall, Dr. W. W. Seifert, Mr. C. M. Edwards, Mr. H. E. Blanton, and others have discussed the advantages of the flight table in the development of aircraft control systems.

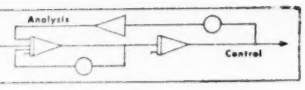
The addition of a flight table to a simulation facility permits the usefulness of the facility to extend to such areas as:

(1) Studies of the effects of actual dynamic response, nonlinearities, and cross-coupling in angular sensing instruments upon overall system behavior.

(2) Evaluation of system performance under transient conditions of mode switching, in-flight engagement, or disturbances arising from within the instruments.

(3) Exposing system shortcomings before actual flight—for example,

*Note spelling!
**You know how hard it is to count with your socks on!



poor signal-to-noise ratios, poor impedance matching, excessive drift, unfavorable system scaling.

Mr. Bond explained that the purpose of his discussion was not to de-emphasize these advantages but to point out precautions which are important in realizing the maximum usefulness of a flight table and to suggest additional indirect applications.

Flight tables contain many sources of error or nonidealities.* Examples are a lagging transfer function, static nonlinearity, poor resolution, backlash and hysteresis. Although these nonidealities are inevitable, they do not destroy the usefulness of the table when properly taken into account. However, it *is* important to be sure that the sources of error in the flight table are much smaller than comparable errors in the equipment under evaluation if any meaningful analytical results are expected.

Dynamic Response

In the original design of a flight table a compromise between physical size and dynamic response is always required. Large size is advantageous for mounting complete control system packages without need for modification or design of special brackets. However, the moment of inertia of the gimbal tends to increase as the fifth power of the representative dimension, whereas the natural frequency is inversely proportional to the square root of inertia. Hence, dynamic response tends to decrease as the five-halves (or greater) power of physical size, and the penalty imposed by a larger-than-necessary flight table is severe.

On the other hand, the penalty for designing a flight table smaller than necessary is even more severe. The equipment to be tested simply won't fit. It appears therefore that the flight table is not really a general-purpose device in the sense that it can test satisfactorily equipment of widely varing sizes and dynamic characteristics.

In a paper by Blanton entitled "Performance Requirements for Flight Tables" presented at the National Simulation Conference in January 1956, Blanton presents curves indicating the required response characteristics of a flight table for accurate simulation. Although no simple rule is applicable, the flight-table driving servos have to be about 10 times faster than the system being simulated to obtain an accuracy within 15%, and this accuracy applies only over a narrow range of damping ratios.

Dynamic Range

The region between the lowest controllable rate and the maximum rate of a gimbal servo may be referred to as the useful dynamic range. A similar definition may be applied to the region between minimum and maximum acceleration. Although the flight table may provide accurate simulation at rates approaching the upper limit very closely, it is important to stay well above the lower limit (sometimes called "rate resolution"). Since the simulated vehicle may have a dynamic range of interest in the neighborhood of 100 to 1, the simulator itself should have a range of at least 1000 to 1 and preferably 10,000 to 1 to obtain accurate simulation at either extreme condition. (Most frequently, these extreme conditions require the closest study.) Realizing a wide dynamic range places stringent requirements on the gimbal servo performance. Important items include low backlash, low static-friction, high loop-gain, and precision feedback sensing. However, because of limitations in the practical extent of the dynamic range, this factor emphasizes the importance of scaling the simulator appropriately to the problem.

Complexity

The flight table and its control system inherently involve a considerable degree of complexity. Achieving high dynamic response at high power levels with high precision in today's state of the art requires a multiloop hydraulic servo system. Three-degrees-of-freedom motion requires at least three gimbals and servos. Furthermore, if certain restrictions to avoid gimbal lock are unacceptable, then a fourth gimbal and servo are needed. To produce the proper motion of the gimbals from acceleration or rate inputs computed in body axes, a signal-resolving system is required. This system involves a resolution of each signal through each gimbal angle. All these items, plus the analog equipment usually needed for five or six degrees-of-freedom simulation, are required.

Accuracy and reliability both decrease in proportion to the complexity of a system. Consequently it is inevitable that the accuracy and reliability of a simulator including a flight table will be worse than the equivalent analog equipment. Longer problem set-up and checkout times are necessary and longer maintenance times can be expected. For this reason the use of a flight table over purely analog simulation must be justified against factors of more costly and less accurate results.

An example of inefficient usage of a flight table might be the evaluation of a vertical gyro for flight control of an aircraft. Let's say that a typical gyro is mounted on the flight table and that its signals are transmitted to simulated control-surface servos. The resulting surface deflections are applied to the basic aerodynamic equations, which then provide controlling signals for the table. With this set up presumably the effects of cross-coupling and nonlinearities in the gyro can be studied. From a practical point of view it is doubtful if the flight table gimbal structure is more accurately fabricated than that of the gyro. Moreover, nonlinearities —stiction, backlash, and rate limits —of the table are probably more significant than those of the gyro. Finally, a pendulous erection system in the gyro will not function at all realistically since linear acceleration cannot be included. Therefore, it would seem that such a setup would be more likely to demonstrate the effects of flight-table nonidealities than gyro nonidealities on the control system— and at considerable expense.

Having enumerated a few of the pitfalls in using flight tables, let us look at practical, realistic applications.

Nonlinearities and Coupling

The flight table can provide effective simulation when the hardware under test is considerably more nonlinear than the flight table. Examples of such usage would include testing of

(a) Seeker systems with antennas or radiation detectors gimballed in two degrees of freedom;

(b) Gyro systems using on-off or other nonlinear control methods;

(c) Control systems featuring digital sensing devices and controls.

In all three cases, particularly the two latter, the effects of nonlinear properties of the components being tested can usually be distinguished from simulator nonlinearities.

*Wow!

Transient Characteristics

Transient characteristics under linear operating conditions can usually be determined without the use of a flight table; however there are some conditions of nonlinear operation in which a flight table may be very helpful. An example is evaluation of the transient following a disturbance which drives a sensing instrument beyond full scale. Another situation might involve multimode operation of an antenna-drive servo with the objective of studying transient characteristics. In both examples the abrupt changes in both dynamic characteristics and linearity necessitate physical motion to assure a valid test.

Debugging, Checkout, and Training

Some of the most valuable applications of a flight table may be the least obvious.

Experience has shown many times that some system shortcomings are not exposed until the equipment is in the field or is in actual flight. The need for frequent adjustment of an inaccessible potentiometer or the difficulty of setting an accurate null due to noise may go unnoticed until complete system checkout. A limit-cycle oscillation due to nonlinearities may be observed for the first time in actual flight.

The checkout procedure may permit an excessive accumulation of tolerances which may allow a condition of unsatisfactory stability or transient response to occur. The checkout procedure may be greatly improved by modifying the order of certain items. Perhaps the checkout procedure requires switch positions which are incompatible with the operation of auxiliary equipment.

These are only a few examples of the thousands of things which could remain undetected until preflight checkout or actual flight. Use of the flight table makes possible a fairly realistic dress rehearsal for the impending flight test. Use of the entire control system including sensing elements permits the field checkout procedure to be applied, followed by a simulated flight. This procedure provides an excellent situation for revealing system "bugs" or deficiencies. By this means many time-consuming problems can be eliminated before the equipment reaches the field.

Even after completion of a test flight, successfully or unsuccessfully, the flight table may be the necessary tool to study and determine the reason for unusual or detrimental behavior. This step may be indicated if sufficient evidence points to a problem of instrument coupling, nonlinearity, or unexpected transient behavior. Although the flight table is not the only method of conducting a "post mortem," it may prove to be a powerful tool compared to simply repeating a test flight.

Finally, there is no better training for the field crew than working with the actual equipment under realistic operating conditions. The flight simulation facility provides this opportunity. The crew can work directly with development and design engineers during the training stage, which provides an excellent opportunity to learn not only the operating procedures but some of the why's and how's. This close contact with the field crew is also beneficial to the designer in making him more aware of the problems which come up in the field.

Conclusions

The advantages in using a flight table in a simulation facility can be seen more objectively if the requirements and the limitations of the equipment are clearly defined for the specific application. Since the flight table is not a truly general-purpose device, its characteristics must be tailored somewhat to the intended application. Because of the inherent complexity of the flight table, you must make sufficient allowance for the time, manpower, and expense required for operation and maintenance. When these factors are taken into account, the flight table can fulfill very useful applications in analysis, evaluation, debugging, and training.

Uplinger on Experiences with the Bendix Flight Simulator

The essence of the story that *Willard Uplinger* told of experience with the Bendix Flight Simulator (computer and flight table) at NAMTC was that it's a "different order of beast" as compared with "ordinary" analog computing equipment. Besides the table itself there are AC amplifiers, electronic multipliers, and resolver chains which must be calibrated every day or oftener. Calibration of a resolver chain requires 36 steps, and there are four chains; a multiplier channel requires six, and there are 14 channels—224 operations right there: There are "too many screwdriver adjustments and too many screwdrivers." And there are many other chances for human error such as remembering to switch back to "operate" after calibration.

The history of this particular equipment has led to more repairs than expected. For one thing, it is the prototype, without serial number. (North American has serial no. 1, Holloman serial no. 2.) So it is comparatively old, and it suffered from shock when moved to Point Mugu from Detroit. Insulation was worn through, wires were broken, and more than 200 tubes had to be replaced.

However, the equipment has been successfully used on one big and several smaller problems. One "Wha' Hoppen" problem arose when a certain missile exhibited all the aerodynamic performance characteristics of a brickbat. The autopilot was put on the flight-table, and the unsatisfactory flight duplicated and correlated with photographic coverage. Based on the findings from this simulation, the autopilot was redesigned and successfully flown.

In another case a spin-stabilized missile, in which the control signals are distributed to the proper control surfaces through a commutator, was studied. The commutator unit was placed on the flight table to determine the effect of cross-talk while a series of human pilots in a simulated control-plane cockpit in another room made target runs. As an extra added attraction the control systems were changed without the pilot's knowledge.

Referring back to Willard's wail about calibrations and repairs at the beginning of his talk, your Editor asked if he thought it was all worth while.

"Judged by final results," Willard

Entering the Station Theator at Point Mugu are (L to R) *R. H. Peterson*, Laboratory Evaluation Officer, NAMTC; *McLeod*, Convair Astronautics; *Capt. C. H. S. Murphy*, Director of Tests, NAMTC; *J. E. Sherman*, Lockheed Missile Systems Div. (Official Photograph U. S. Navy)

replied, "The answer must be yes. The contractor's impatience while we seemed to fumble made me dwell on the difficulties, but the results were very worth while."

"If you hadn't had the simulator couldn't you have solved the problems by some other method?" Willard was asked.

"Well, after you know the answer it is often easy to see that it could have been obtained some other way," Willard said, "But we didn't have the answer, we did have the table, we used it, and we got the answer!"

Maudlin on NOTS Experiences

L. Z. Maudlin (Naval Ordnance Test Station, Pasadena, Calif.) opened his talk with a reference to the question as to whether or not Willard thought it was all worth while. "If that question had been asked of me I would have unhesitatingly said yes, a thousand times over. Our maintenance and calibration problems, too, are an order of magnitude different from those of an ordinary analog computer—but in the opposite direction. We have practically none."

Before 1944, when the NOTS table was started, every torpedo produced was run in the water before delivery to the Navy. The table was designed to break this expensive wartime bottleneck by taking complete production torpedoes and putting them through a simulated water run, but it wasn't finished in time. It was completed in '49 or '50, lay idle for a year or so, and has been in continuous use ever since.

Of necessity a large table (it can handle a 2,000-pound torpedo and has recently been *lightened* by *two tons*), it is basically a 40mm gun mount. So, the way the Navy builds things, it can take a terrific beating. It is controlled by an AC analog computer and powered by a 30-horsepower motor driving a hydraulic pump, to give a frequency response of about 2½ cycles at ±5°.

Initial success was achieved when several basic parts of a torpedo control system were redesigned as a result of a simulator study—and the torpedo worked when they put it in the water! Since then every torpedo developed by the Navy has gone through the simulation laboratory for developmental research and evaluation.

One dynamically unstable "fish" had no feedback; it was necessary to assume that commands were accepted. The Navy thought it would be comforting to know that such a lethal piece of hardware wouldn't turn around and come back, so after weeks of work on the simulator the system was redesigned to be stable.

With additional equipment the table is also used to develop and evaluate homing systems. In this case a DC analog computer determines where the target is with respect to the torpedo and, by means of a servo, positions the torpedo transducer relative to an acoustic "target" in a tank 22 feet deep and 12 feet square which is lined with acoustically absorbent material. The torpedo in the table controls the program, searches for the target, finds it, and responds with rudder and elevator motions which cause the table to reorient the torpedo.

"The main point of all this simulation is, how good is it? We have made tens of thousands of runs, at a cost of about $10 a run, year in and year out. By contrast it costs $2,000 or $3,000 to make one run in the water."

Mr. Maudlin then showed slides of torpedo tracks and simulated runs. He explained that NOTS plans to build a new flight table which will be about the size of the MIT table now at Wright Field. It will have a higher response characteristic than their present table because torpedoes, like all other missiles, are getting faster and faster.

In answer to a question, Maudlin replied that contractors do often analog their torpedoes to optimize design, but they usually simulate only their own hardware. This is quite different from the simulation of the complete control loop, including homing.

D. H. Lipscomb (Northrop-Nortronics) characterized his flight-table experience by saying that it lay somewhere between that of Willard Uplinger and Lloyd Maudlin. To illustrate he described two of the jobs they had done with it, one in which the table was used to determine the tolerance limits of rate gyro nonlinearities, and one in which the effect of vertical gyro erection rate was investigated. Unfortunately because of the rather high noise-to-signal ratio of the Simulation Council's tape recorder, and because the talks were not written, details of his and the following talk cannot be reported here.

Information (Without Theory)

In our March Newsletter we cracked "Notable by its absence was any mention of simulating a digital on an analog computer . . ."

Now we note that *Naoji Morishita* was scheduled to present a talk "Analog Simulation of Digital Computer Operations" at the April meeting of the Eastern Simulation Council. We await with interest a writeup of that meeting.

* * *

A recent letter from *Stephen Juhasz*, Executive Editor of *Applied Mechanics Reviews* says in part:

"During a recent visit of *Professor William Prager* to Southwest Research Institute he . . . mentioned his present interest in simulation of traffic problems . . . Please find enclosed a recent issue of AMR which might be of some interest to you. Also enclosed I am sending a few papers on Hydraulic Analogies of Heat Exchangers written and co-authored by myself."

I mention this because

(1) I know you will be pleased to hear that somebody is working on the traffic problem.

(2) AMR "A Critical Review of the World Literature in Applied Mechanics and Related Engineering Science," published by the ASME and edited by Southwest Research Institute, might be of interest to many of you.

(3) The "Papers on Hydraulic Analogies of Heat Exchangers" would seem to describe work of importance to not only those interested in simulation but also all concerned with industrial process analysis or control.

* * *

Have you seen the literature on George Philbrick's K5-U "Analog Computer with a New Twist"? As I read it the "new twist" involves:

(1) Use of a three-decade incrementally-set resistor network on each of four amplifier inputs and another for the initial condition to allow "digital" pot setting.

(2) Use of a —.0. + switch in connection with each input to obviate the need for inverting amplifiers.

(3) Decade selection of computing time from "Real" to a thousand times that speed.

(4) The prewiring of these "Pots" to

each amplifier to reduce patchboard complexity, increased reliability, and to produce a convenient computer building block for panel mounting.

Chopper-stabilized, at $675 this component sounds interesting.

He Went Thataway:

Dr. H. R. J. Grosch, formerly with General Electric in Arizona, to IBM in New York.

Thot

(as published in the **Toastmaster**, March 1958)

"The true way for one civilization to 'conquer' another is for it to be so obviously superior in this or that point that others desire to imitate it." *Goldsworthy Lowes Dickinson*

Computer Events

Computer and Automation Conference

Dates: 2-4 June 1958
Place: University of Texas, Austin, Tex.
Under sponsorship of University of Texas

Midwestern Simulation Council

Date: 9 June 1958
Place: North American Aviation 4300 East Fifth Avenue Columbus, Ohio
Subject: "Cute Tricks in Simulation"

For further information check with Jerome D. Kennedy, Secretary of the Midwestern Simulation Council, c/o Electronic Associates, Inc., 101 South Pine St., Mount Prospect, Illinois.

Fourth International Automation Exposition and Congress

Dates: 9-13 June 1958
Place: Coliseum, New York, N. Y.
Subject: 90-minute Clinic Classes on real-time and fast-time analog and digital computers, and symbolic logic.

For info contact Rimbach Associates, 845 Ridge Ave., Pittsburgh, Penna.

Association for Computing Machinery—Annual Meeting

Dates: 11-13 June 1958
Place: University of Illinois, Urbana, Ill.

University of Michigan—summer session

Dates: 16-27 June 1958
Place: Ann Arbor, Michigan
Subject: "Courses in Computer Science and Engineering"

Information may be obtained from the Engineering Summer Conference Office, 2038 East Engineering Building, University of Michigan, Ann Arbor, Mich.

Denver Research Institute

Dates: 24-25 July 1958
Place: University of Denver, Denver, Colorado
Subject: Fifth Annual Symposium on Computers and Data Processing
The symposium will emphasize Formalized Analysis Techniques, Systems Organization, Logical Design Techniques, Automatic Programming. For more info write C. A. Hedberg, Head of the Electronics Division, Denver Research Institute, Denver 10, Colorado.

Wescon

Dates: 19-22 August 1958
Place: Ambassador Hotel and Pan-Pacific Auditorium, Los Angeles, Calif.

Association Internationale pour le Calcul Analogique

Dates: 1-9 September 1958
Place: Strasbourg, France
Subject: "Journées Internationales de Calcul Analogique"
An exhibit of analog equipment will open 30 August and continue until 10 September. For information write Monsieur F. H. Raymond, 138 Boulevard de Verdun, Courbevoie (Seine), France.

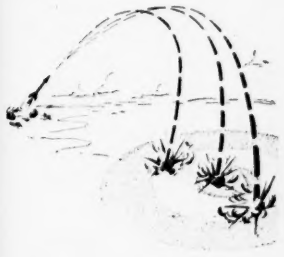
National Simulation Conference

Dates: 23-25 October 1958
Place: Statler-Hilton Hotel, Dallas, Texas

The conference will be sponsored by the IRE PGEC and the Dallas Section of the IRE.
One hundred-word abstracts and 500-word summaries should be sent in duplicate to Mr. D. J. Simmons, Route 8, Box 447, Fort Worth, Texas. Deadline is June 25th.
For further information on the conference write J. E. Howard, 2100 Menefee Dr., Arlington, Tex.

ARE any new fields of computation opened up by the GPS High Speed Analog Computer?

YES, the statistical evaluation of the performance of systems perturbated by random noise can now be accomplished at high speed. With the system simulated on a



high speed computer such that the solution is carried out several thousand times faster than real time, samples of a random variable such as the miss distance of a missile system can be taken at rates up to 50 per second. Thus, sample sizes of several hundred can be taken in a few seconds' time.

GPS has a complete line of equipment to generate random noise for introduction to the system and to monitor the output. RMS values of random variables can be measured directly and complete probability distribution functions can be determined with statistical confidence in a matter of minutes.

IF you have problems requiring immediate analysis, the GPS Computer Center in Boston can provide analog facilities and experienced engineering assistance to suit your needs.

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For more information circle **97** on inquiry card.

new instruments

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recorders

OSCILLOGRAPH

New Model 906A Visicorder supplements original Model 906 in response to users' demands: as many

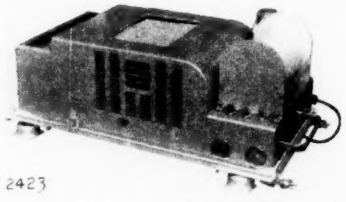
2495

as 14 channels, each at frequencies up to 3000 cps, with factory-installed optional features for trace identification, "grid lines" (amplitude reference coordinates) and adjustable recording intensity control. Various optional accessories such as timing system, takeup units etc. Two models: 906A-1 utilizes miniature plug-in galvanometers and magnet assembly interchangeable among Models 906-A-1, 708C, 712C and 1012; 906A-2 retains solid-frame galvanometers and magnet assembly from original 906.—*Minneapolis-Honeywell Heiland Div., 5200 E. Evans Ave., Denver, Colo.*

For more information circle **501** on inquiry card.

AIRBORNE OSCILLOGRAPH

New Electrograph Model 422 has been selected by CAA's Flight Inspection Division as the direct-writing recorder to be used in CAA's expanded airways flight inspection program. Electrograph recording paper can be handled and loaded in daylight; instrument will operate in direct sunlight; has the same basic design as Model 420, but has been engineered



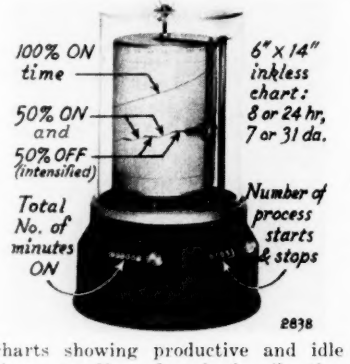
2423

to operate as an airborne unit. It is a 24-channel oscillograph, using both 28 vdc and 110-v 400-cps; carries a 200-ft roll of recording paper which provides for continuous operation up to 320 hours.—*Century Electronics & Instruments, Inc., 1333 N. Utica, Tulsa, Oklahoma.*

For more information circle **502** on inquiry card.

OPERATIONS RECORDER

New Efficiency Recorder, most versatile addition to maker's line of vertical-drum instruments, yields


100% ON time
50% ON and 50% OFF (intensified)
Total No. of minutes ON
6" X 14" inkless chart: 8 or 24 hr, 7 or 31 da.
Number of process starts & stops

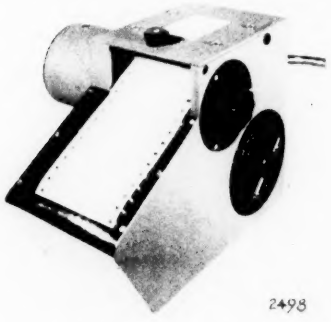
2838

charts showing productive and idle time, etc. Use of maker's vibration pickup will show when certain machines are producing, not merely when their motors are running. Also available are photoelectric and other types of pickups.—*Gorrell & Gorrell, Westwood, N. J.*

For more information circle **503** on inquiry card.

OPERATION RECORDER

New multi-channel Lind-Recorder simultaneously records on electrosensitive paper many events of on-off,



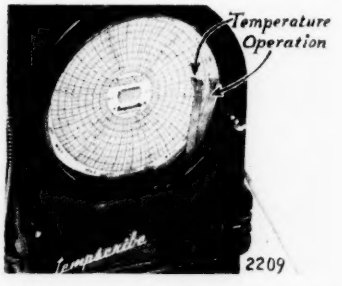
2498

yes-no or here-there types; is available with 44 or 68 recording channels and with paper speeds of 2, 4, 8, 16 or 32 iph.—*Lindly & Co., 248 Hericks Rd., Mineola, N. Y.*

For more information circle **504** on inquiry card.

TEMPERATURE-OPERATION RECORDER

Newest member of maker's line of Tempscribe Recorders is made in two standard temperature ranges: —30



2209

to 50° F and —30° to 120° F; for either series or 110/220-v ac or dc parallel operation connection; 6-ft electrical cord and 6-ft capillary; 24-hr instrument-type clock chart drive; comes with 100 4¼" paper charts and a bottle of ink.—*Bacharach Industrial Instrument Co., 200 N. Braddock Ave., Pittsburgh 8, Pa.*

For more information circle **505** on inquiry card.

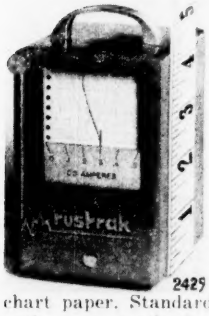
MULTIPLE BANK RECORDER

New Dynamaster Multiple-Bank Recorder, for continuous printing and for alarm scanning, prints up to 200 inputs on a 12" strip chart; features easy reading and point identification; continuously synchronized point identification; high scanning rates for intermittent use. Scanning continues through alarm or printing functions. Measuring circuits include millivoltmeter, milliammeter, tachometer, pyrometer, dc bridge, ac bridge, etc. Available: alarm lights or other device; switches for deleting any bank or banks from recording or scanning

sequence; selector permitting instrument to indicate only, to print only on alarm condition.—*The Bristol Co., Waterbury 20, Conn.*

For more information circle **506** on inquiry card.

INKLESS RECORDER



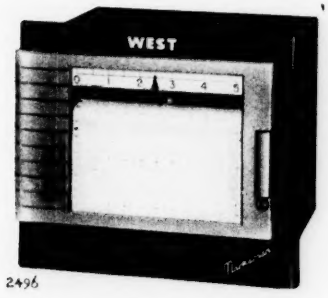
2425

New small low-cost Rustrak utilizes simple deflecting-pointer-type ac or dc movement, with chopper bar to make pointer edge produce a series of dots on pressure-sensitive strip-chart paper. Standard chart roll duration one month. Available in many ac and dc ranges with 1% accuracy for most ranges (2% for high-sensitivity ranges). Maximum response time 1 sec for full-scale travel.—*Rust Industrial Co., Inc., 330 Silver St., Manchester, N. H.*

For more information circle **507** on inquiry card.

STRIP CHART RECORDER

New Marksman, first in Model M Series, is said to be a truly distinctive strip-chart potentiometer recorder.



2496

Free of vacuum tubes, it uses printed circuits and transistors in its amplifier, therefore operates instantly (no warm-up) and "functions far longer without maintenance." Among features: Automatic standardization, thermocouple break protection, cold-junction compensation, adjustable chart speeds without changing gears, battery condition indicator, etc. Wide selection of scale ranges and chart speeds permits recording strain, pH, temperature, pressure, etc.—*West Instrument Corp., 4363 W. Montrose Ave., Chicago 41, Ill.*

For more information circle **508** on inquiry card.

RECORDER FOR COMPUTERS

New Model MC-300 six-channel rectangular-coordinate chart recorder, said to be the first rectilinear ink-writing recorder offered the computer

Quick Response - Fine Sensitivity

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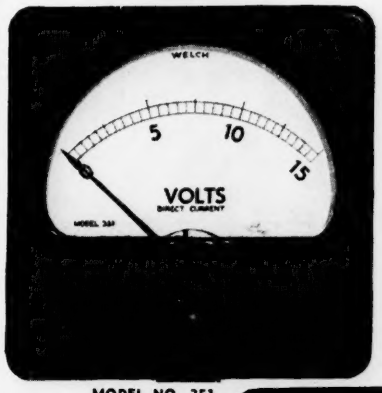
• Accuracy 2% of Full Scale Deflection

MODEL NO. 350

Welch Model 350 Panel Meters are often used in temporary "bread-board" assemblies and in "homemade" devices so common in electronics laboratories. In such work it is frequently more convenient to have an attached rather than a separate meter.

Suitable for such applications as measuring grid currents and currents from photoelectric tubes and cells. They have alnico magnets, sapphire bearings, and especially selected pivots to make possible the extremely sensitive 20 microampere movement.



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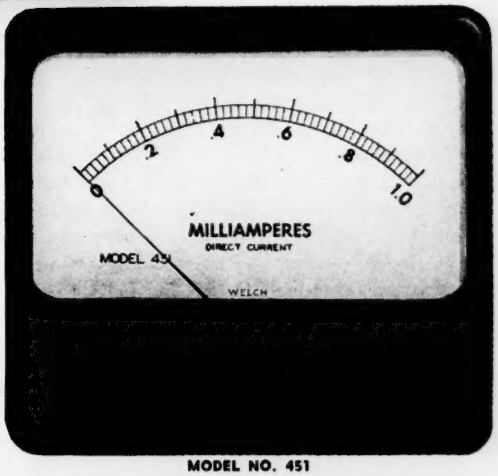

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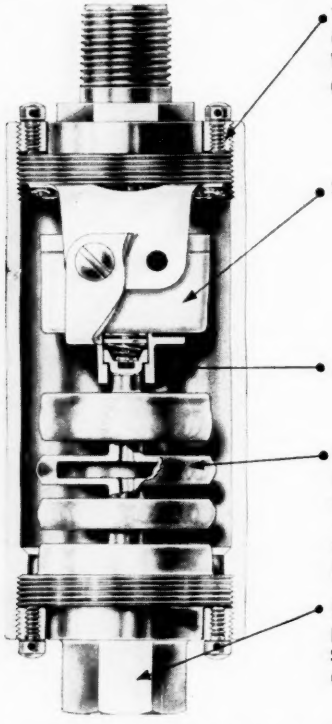
DIVISION OF W. M. WELCH MANUFACTURING COMPANY
ESTABLISHED 1880
1515 SEDGWICK STREET, DEPT. C-2, CHICAGO 10, ILLINOIS, U.S.A.
Manufacturers of Scientific Instruments and Laboratory Apparatus

For more information circle **98** on inquiry card.

NEW PRESSURE SWITCH FOR HIGHLY CORROSIVE MEDIA


Threaded (adjustable) Construction Shown; Welded construction optional
Snap action Switch
Overtravel protection
Welded multiple diaphragm sensing element —not to be confused with an accordion bellows.
¼" internal pipe thread pressure connector is standard—Welding fitting optional.

SAVE EXPENSE OF CHEMICAL PROTECTORS...OFTEN MORE THAN THE PRICE OF THE PRESSURE SWITCH

This new tier-tube line of Meletron pressure switches is available in materials suitable for use with concentrated hydrogen peroxide, fuming nitric acid, liquid oxygen, proprietary amine fuels, fluorine, mixtures of fluorine and liquid oxygen and others.

Proof pressures range from 224 to 6000 P.S.I., pressure settings from 2 to 4800 P.S.I. Switches will operate in temperatures from −65° to +275° F. Standard pressure port fitting is ¼" internal pipe thread but may be substituted by special welding fitting. The housing serves as a pressure tight safety capsule in case of a break in the sensing element. Single pole double throw switching elements are rated to 10 amps., for AC and DC circuits. Free leads or Cannon plug are optional for electrical connection. As an added safeguard, the stainless steel models will withstand 2000° heat for five minutes.

Write for bulletins 1110 to 1170.

PRESSURE SWITCH DIVISION

barksdale valves

5125 ALCOA AVENUE • LOS ANGELES 58 • CALIFORNIA

For more information circle **99** on inquiry card.

Petrometer
SERIES 1400
LIQUID DEPTH GAUGES

ACCURATE and EASY TO INSTALL

Available in 4 Models, Petrometer Series 1400 Tank Gauges operate on the sound principle of hydrostatic pressure. No moving parts, no expensive electrical or electronic equipment. Large vertical scale gives accurate, easy-to-see reading. And construction features make installation easy.

For complete information send for Bulletin 6004

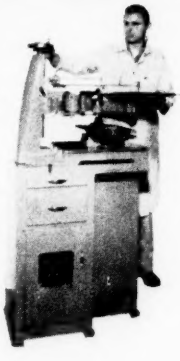
Petrometer
CORPORATION

43-22 TENTH ST., LONG ISLAND CITY 1, N. Y.

For more information circle **100** on inquiry card.

ENGRAVERS are fast!

- Spindle speeds up to 26,000 rpm to engrave or for machining modern materials
- Fastest possible copy set-up
- Greatest ease and speed of adjustments
- Cutter grinders, rotary tables, master letters, compound slides, name plate blanks and all required accessories



MODEL D2 HEAVY-DUTY 2-DIMENSIONAL

- 575 pounds-rigid, sturdy, precise
- Vertical adjustment of copy table automatic with Pantograph
- Unobstructed on three sides to take large work
- Vertical range over 10 inches
- Micrometer adjustment for depth of cut
- Ball bearing construction throughout — super precision ball bearings in spindle
- Ratios 2 to 1 to infinity — master copy area 26" x 10"

MODEL 106 PORTABLE BENCH MODEL- 2- OR 3-DIMENSIONAL

- 40 pounds of unbeatable speed and accuracy at a reasonable price
- Perfect for all machining applications within its range
- Ball bearing spindle has three speeds up to 14,000 rpm
- 5 positive, accurate pantograph ratios
- One copy carrier (supplied) accepts all master sizes
- Height of pantograph and position of cutter are continuously adjustable
- Work up to 10" by any width
- Taper shank cutters

GREEN INSTRUMENT CO., INC.

383 Putnam Avenue Cambridge, Mass.

For more information circle **101** on inquiry card.

industry, uses low-cost permanent easily-handled and -reproduced chart paper; features constant input impedance independent of input attenuator setting or frequency; mechanical and electrical (10-turn pot) zero balance control; self-contained power supplies; ink or electric-stylus pens; extra time marker channel; automatic sequence control; limit control of all channels; internal standard cell for channel gain calibration; paper speed regulation within 1%.—*Mid-Century Instrumatic Corp.*, 611 *Broadway, New York* 12, *N. Y.*

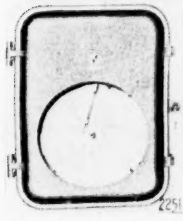
For more information circle **509** on inquiry card.

SHIPPING SHOCK RECORDER

New Model SR-1 reports whether a valuable shipment cargo has been jolted beyond a preset limit, even during a small fraction of a second; is simply attached inside shipping case (or on cargo itself if feasible). A fuse is blown if a preselected allowable level of shock acceleration is exceeded for a time greater than a preselected duration, for example 20*G* and 0.01 sec.—*Dynamic Measurements Corp.*, 40 *So. Los Robles Ave., Pasadena, Calif.*

For more information circle **510** on inquiry card.

SHIPPING TEMPERATURE RECORDER

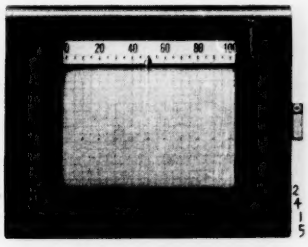


New all-weather temperature recorder yields positive proof of temperatures maintained on perishable goods in transit by truck, rail or ship; resists shock and vibration; has anti-tamper lock; is accurate to 1% of scale range. Eight-day clockwork chart drives; choice of 24-hr, 48-hr and 7-day charts.—*The Partlow Corp.*, 507 *Campion Rd., New Hartford, N. Y.*

For more information circle **511** on inquiry card.

X-Y RECORDER

New Dynamaster *X-Y* recorder is of automatic self-balancing type, available as a dc potentiometer or re-

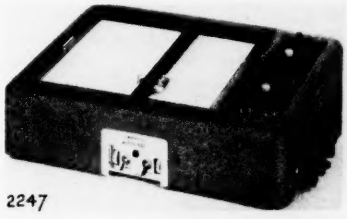


sistance bridge. Maximum dead-band < 0.1% of full-scale for *X*-axis and < 0.2% on *Y*-axis. Minimum range using maker's No-Batt continuous standardization is 3 mv dc. Standard speed 3 sec on each axis for full-scale pen or chart travel. Automatic chart advance is available.—*The Bristol Co., Waterbury* 20, *Conn.*

For more information circle **512** on inquiry card.

XY & TIME-BASE RECORDER

New Autograf X-Y-T is an *X-Y* recorder with built-in time base or sweep circuit on *X* axis. Instantly

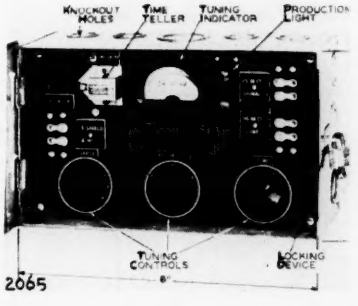


selectable are five calibrated time intervals of 5 to 500 sec for full-scale *X* axis pen travel. When time base is not used, regular two-variable plotting can be accomplished as desired. New time base feature is available on all Autograf models.—*F. L. Moseley Co.*, 409 *N. Fair Oaks Ave., Pasadena, Calif.*

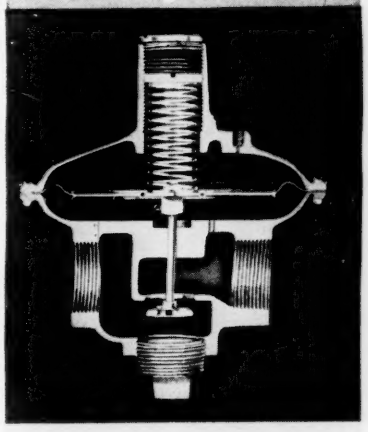
For more information circle **513** on inquiry card.

PRODUCTION TIME RECORDER

New Model LH Time Teller measures in hundredths of hours the actual productive time of industrial machines whether they are manually,



WHAT'S INSIDE MAKES A BIG DIFFERENCE



Regulators and Controls are as good as the diaphragms actuating them.

Vulcan diaphragms have been accepted and depended on for almost 25 years.

Low gauges are available with excellent flexibility for delicate applications. Heavy gauges with high strength for rugged service are available in many coating compound types.

Vulcan provides integrated research, development and manufacturing facilities. This means complete quality control from raw material to finished product; assuring you that every diaphragm is made to strict specifications.

A vital part of this Vulcan integration is our research and development laboratory. If you have a diaphragm problem, we shall be happy to consult with you.

Another REEVES VULCAN RUBBER PRODUCT

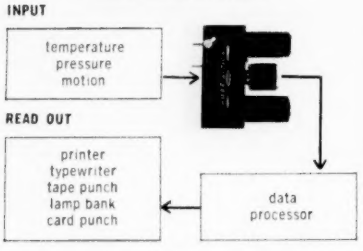
Write to: Dept. I-85
REEVES BROTHERS INC.
Vulcan Rubber Products Division
84 Worth Street • New York 13, N.Y.

For more information circle **102** on inquiry card.

HOW TO RECORD DIGITALLY AND POSITION AUTOMATICALLY

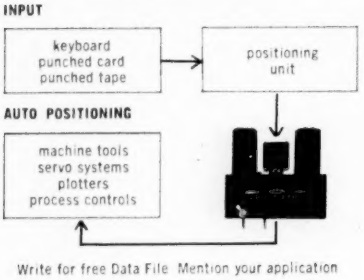
DIGITIZER

RECORDING SYSTEMS



For years Coleman **DIGITIZERS** have been widely known and used for converting analog motion into discreet digital information. **NOW!** (shown below) Coleman **DIGITIZERS** are being used to establish automatic positioning from standard digital information.

POSITIONING SYSTEMS



Write for free Data File. Mention your application

Your name_____

Company_____

Address_____

Coleman

ENGINEERING COMPANY, INC.
6040 West Jefferson Boulevard
Los Angeles 16, California

For more information circle **103** on inquiry card.

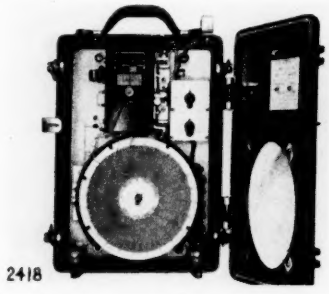
NEW INSTRUMENTS

electrically, hydraulically, or pneumatically powered. It is actuated through a Con-Trol-Ear vibration pickup or by a rotary pickup. Extremely stable high-gain amplifier uses Motrons—an exclusive development in equalization network circuitry.—*Moseley Electronics Co., 330 Locust St., Hartford, Conn.*

For more information circle **514** on inquiry card.

ELECTROLYSIS RECORDER

New weatherproof-case Model 1VB-621 millivoltmeter electrolysis recorder, for use in pipe-line, cable or

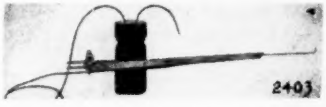


foundation surveys, has eight instantly-available self-contained ranges; records frictionlessly by vibrating-pointer on 8" carbon-coated chart; has two-speed spring-wound chart drive 24 hr/96 min movement.—*The Bristol Co., Waterbury 20, Conn.*

For more information circle **515** on inquiry card.

CHART PEN

New Arcco Cannon Never Dry Pen writes for months without servicing; easily replaces others; uses regular



brands of ink; makes clean and complete records. Ink bottle is placed in instrument case and capillary tube feeds pen with continuous flow. Closed system sealed from atmosphere prevents clogging and dirt accumulation.—*American Recording Chart Co., 3113 E. 11th St., Los Angeles 23, Calif.*

For more information circle **516** on inquiry card.

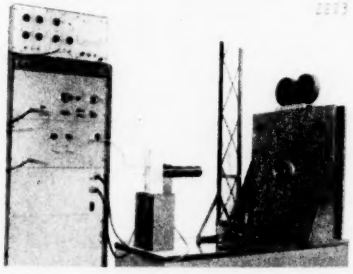
OSCILLOGRAPH GALVANOMETER SIGNAL OVERLOAD PROTECTOR

New Automatic Electronic Signal Limiter prevents oscillograph galvanometer burn-out due to input signal overload while permitting amplifier to run with linearity through entire galvanometer pen-recording range. Unlike a fuse, it activates whenever needed, without stopping normal pen movement. Pens can be safely adjusted for full deflection over entire usable chart-paper width. It is standard equipment on all new Edin amplifiers; can be factory-installed on existing amplifiers.—*Edin Co., Inc., 207 Main St., Worcester 8, Mass.*

For more information circle **517** on inquiry card.

ULTRASPEED CAMERA

New model of ultraspeed photographic system has picture rate up to 1,000,000 frames/sec for 700 succes-



sive pictures (highest known total number of successive pictures at this rate); has been thoroughly tested in studying dynamic properties of materials, photoelastic strain fringes, strain pulses, and collapse of ultrasonic cavitation bubbles. Two other important features: exposure time independent of picture rate and magnification of small objects.—*Dynamic Measurements Corp., 40 So. Los Robles Ave., Pasadena, Calif.*

For more information circle **518** on inquiry card.

RECORDER SWITCH

New MOR-COR (modulation-operated-relay—carrier-operated-relay) is a switching device or alarm unit whose many applications include switching-on recorders to record incoming telemetering signals or to indicate presence of radio signals (for example while an attendant is away). It can be actuated by an audio signal of sufficient amplitude, a telemetering signal in 20.5-22-Mc region, or both, depending on position of selector switch.—*Westronics, Inc., RF Div., 3605 McCart St., Fort Worth, Texas.*

For more information circle **519** on inquiry card.

TIMING AND RECORDING SYSTEM

New Model 5710-41 was originally designed to measure and record travel time of a missile between points on its trajectory. Pulses generated by movements of missile are sent to two single-channel and two

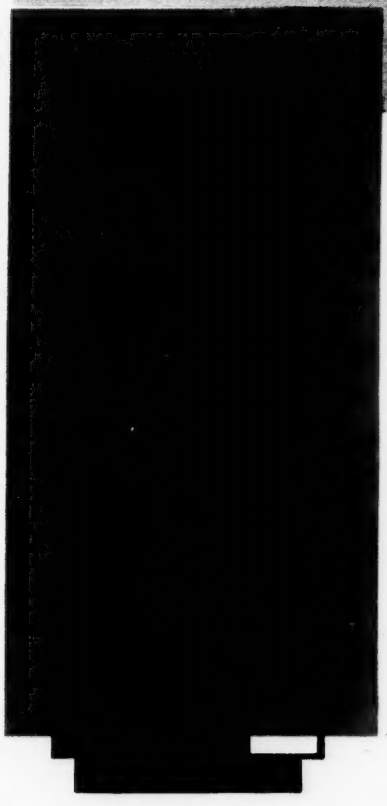
ALLEN-BRADLEY PRESENTS...

NEW METAL GRID

¼, ½, and 1-WATT

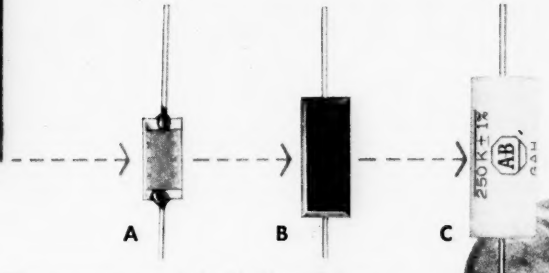
PRECISION RESISTORS

A-B QUALITY



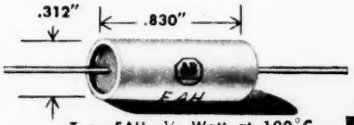
Far exceed MIL Specs for film and wire-wound resistors

Allen-Bradley's new, truly accurate, metal grid resistors are now available in ¼, ½, and 1-watt ratings, producing test results that are a substantial improvement over the MIL Specifications for wire-wound and film type precision resistors. They combine remarkable stability, under load and on the shelf, with an exceptionally low temperature coefficient. The metal alloy grid is noninductive, providing excellent high frequency characteristics. They also have an exceptionally low noise level . . . comparable to that of wire-wound units. Each unit is individually calibrated and marked with nominal resistance value, tolerance (± 0.1 to 1%), and temperature coefficient. Provided with gold plated leads for flawless soldering. Considering their superior characteristics, these new resistors justly qualify under the Allen-Bradley trademark of *Quality*.



Type GAH
1 Watt at 100°C
± 0.1 to 1%

Type CAH—¼ Watt at 100°C

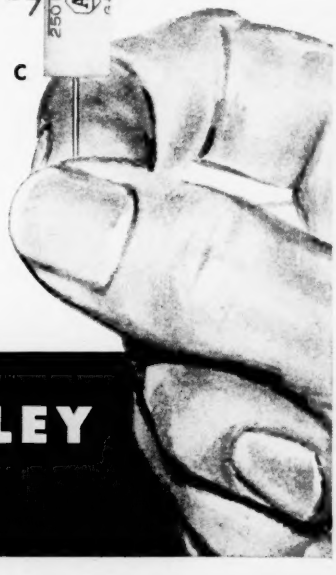


Type EAH—½ Watt at 100°C

Type GAH—1 Watt at 100°C

The construction of the ¼, ½, and 1-watt resistors is identical. At the upper left is an enlarged view of the metal alloy grid, mounted on glass, which forms the resistance element. (A) Actual size of 1-watt element, (B) encapsulating epoxy resin body, (C) finished unit hermetically sealed in ceramic tube.

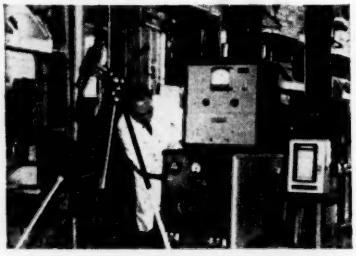
Allen-Bradley Co.
140 W. Greenfield Ave., Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.



ALLEN-BRADLEY

For more information circle **104** on inquiry card.

Critical Problem in Titanium Forging is Solved—



with INFRARED

Republic Aircraft hit problems — heat problems — in forming titanium sections. The metal had to be held within a *close* temperature range even during the actual working under the hammer.

Resistance heating was the natural way for bringing the blanks up to temperature . . . but the stopper was how to maintain adequate control of temperature while handling the metal in the press. Then Republic turned to Servo Corporation's infrared pyrometers, and found they had the answer.

Remote control of the temperature, *without* any connection or contact with the metal or machine, is maintained in this application by the SERVOTHERM® Infrared Pyrometer. The SERVOTHERM provides highly accurate and instantaneous control of the temperature, the process, *or both*, in almost any kind of operation, by measuring the infrared radiation emitted by the material or equipment involved.

Almost any control problem, where heat is a related variable — whether of a basic *or* an incidental nature — is easily solved with a SERVOTHERM Pyrometer System. The effectiveness of infrared control applies to materials or objects that are moving or stationary, whether liquid, solid, or powdered — granular in form, in the temperature range from 40° to 2800°F.

The leading firm in infrared, Servo Corporation of America produces the world's widest range of infrared equipment — systems and components, assemblies and accessories. The modular principle of building custom IR systems from "standard units" is also a Servo Corporation development.

For data on Servo Corporation's infrared equipment, from single items to complete IR systems for almost any type of control function — in laboratory or production line use, write for our new technical bulletin on Infrared Pyrometers, TDS IRPS-R1, or consult our application engineering staff. Call or write:

SERVO CORPORATION of AMERICA

20-26 Jericho Turnpike, New Hyde Park, L.I., N.Y.

For more information circle **106** on inquiry card.

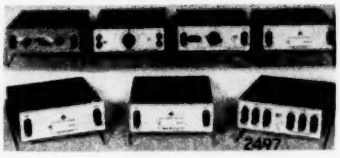
NEW INSTRUMENTS

dual-channel Time Interval Meters where they are counted and registered as digital data. Time intervals of 100 different missiles can be identified. A standard eight-digit Printer records digital data and prints a letter with it which will designate mode of operation. It will operate directly from external pulses, from data already recorded on tape, or in a test function, checking itself against its own time base.—*Beckman Instruments, Inc., Systems Div., 325 N. Muller Ave., Anaheim, Calif.*

For more information circle **520** on inquiry card.

RECORDER ACCESSORIES

New Series 300 accessories greatly expand range and usage of Single and Dual "recti/riter" rectilinear galvanometric recorders: ★Model 350 Multi-Voltage Monitor measures 1 v

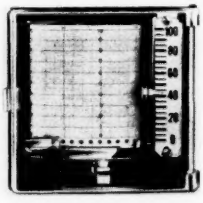


to 1000 v in seven ac and dc ranges. ★Model 351 AC Multi-Current Monitor measures seven ac ranges from 25 ma to 25 amp. ★Model 352 Line Frequency Monitor measures frequency deviation in 45-55, 55-65 or 375-425 cps range. ★Model 353 Line Voltage Monitor measures ac voltage with suppressed zero and expanded scale. ★Model 354 Current Monitor is any single-range of Model 351. ★Model 333 Line Service Monitor is a single-package of Models 352, 353 and 354.—*Texas Instruments Inc., 3609 Buffalo Speedway, Houston 6, Texas.*

For more information circle **521** on inquiry card.

process analyzers, monitors, controllers

INDICATORS AND RECORDERS



New Series 663 Dynamaster instruments take about 5" square of panel space, are available as indicators or recorders with three basic measuring circuits, feature plug-in interchangeability and easily- replaced range cards. Choice of chart drives and change-gears for speeds of 1, 2, or 3 ipm with daily chart tear-off; 31-day record at 1 iph. —*The Bristol Co., Waterbury 20, Conn.*

For more information circle **522** on inquiry card.

PROGRAMMING CONTROLLER

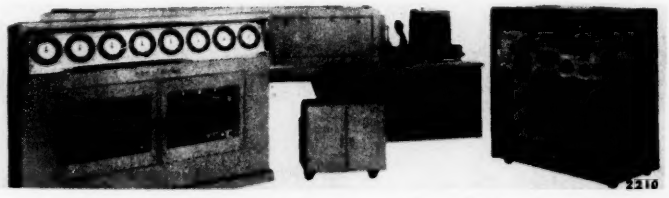
New circuit built around a new kind of contact meter-relay action controls rate and/or magnitude of change of a variable; applies to any variable that can be measured electrically; accomplishes the same programming effect as a closed-loop pulse servomechanism but much more easily; is believed to be the first control circuit to apply a feedback signal directly to a meter-relay as a means of guiding control action. Programming can be set up by cams, punched tape, etc. Meter-relay signal is absolute and direct, without distortion or drift that results from amplification necessary in an electronic hook-up. Circuit is so sensitive that "a tiny fraction of the signal" can represent a full-scale pointer deflection.—*Assembly Products, Inc., Chesterland, Ohio.*

For more information circle **523** on inquiry card.

ELECTRONIC GO-NO-GO GAGE

New Model 620A monitors any variable (speed, flow, pressure, thickness, etc.) that can be translated in terms of frequency. Upper and lower frequency limits are set on front panel. Any two frequencies falling between

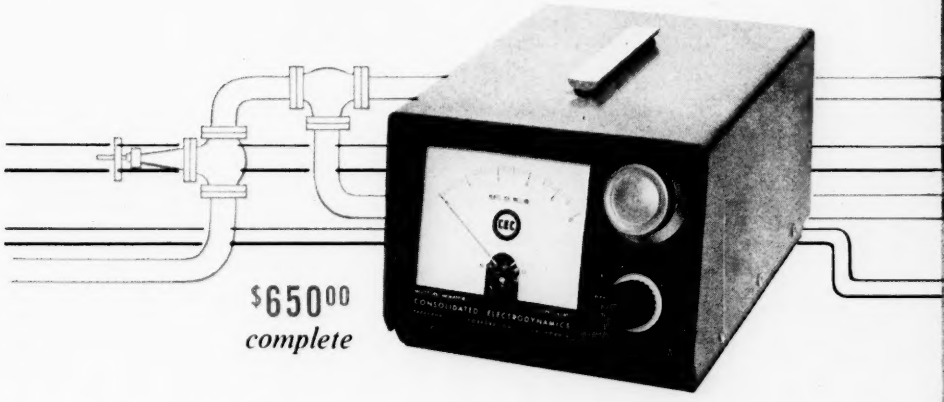
DIRECT-READING ATTACHMENT FOR SPECTROGRAPH



New interchangeable Direct Reading Attachment enables maker's high-resolution 3-Meter Grating Spectrograph to be used for routine control as well as research studies in metals industry. It presents, as percent concentration, readout of eight elements in less than two minutes with precision and freedom from human error. —*Baird-Atomic, Inc., 33 University Rd., Cambridge 38, Mass.*

For more information circle **524** on inquiry card.

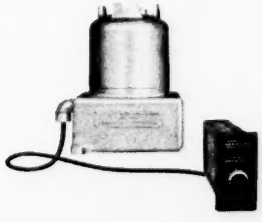
CEC's portable **MOISTURE MONITOR** *guarantees more value for your money*



. . . sales leader in the moisture monitor field

Comparison proves that the CEC 26-301 is your best buy in portable moisture monitors. First to be custom designed from the ground up, the 26-301 has the fastest response with immediate recovery. With a step-function change in sample concentration from 750 ppm to 20 ppm water, this precision instrument will give approximately 63% response in 30 seconds—95% response in one minute. A meter, calibrated in ppm by volume, permits precise readings from 0 to 1000 ppm with better than 5% accuracy guaranteed. Built to highest quality control standards, the 26-301 is fully guaranteed and backed by CEC's field service. *Immediate delivery. Contact your CEC Field Office, or write for Bulletin CEC 1834-X21.*

. . . top performance is also guaranteed for process moisture monitor buyers



Response in seconds rather than hours and exclusive design of the electrolysis cell guarantee top performance from CEC's 26-310 Process Moisture Monitor. The all-weather Analyzer is explosion-proof for Class I, Group D, Division 1 hazardous locations. CEC's 26-310 is capable of remote indication when utilized with a suitable recorder. *Contact your nearby CEC Field Office, or write for Bulletin CEC 1845-X10.*

No matter how complex your moisture problems are, CEC's Application Engineers are qualified to solve them.

CEC is in business to help you solve your specific problems . . . guarantees a satisfactory solution. Whether you need an individual instrument built to custom specifications, or a complete system, simply discuss your objectives with your nearby CEC field office.

Analytical & Control Instrument Division

Consolidated Electrodynamics

300 North Sierra Madre Villa, Pasadena, California

OFFICES IN PRINCIPAL CITIES THROUGHOUT THE WORLD

Here's information you'll want on STANDARD precision timers

STANDARD TRADEMARK

Accurate, reliable, versatile Elapsed Time Indicators. Synchronous motor drive, manual or electric zero reset. Electric clutch controlled by manual or automatic switch or output of electronic tubes. Units available for flush panel mounting or portable use.

Model	Scale Divisions	Totalizes	Accuracy
S-100	1/5 sec.	6000 sec.	±.1 sec.
S-60	1/5 sec.	60 min.	±.1 sec.
SM-60	1/100 min.	60 min.	±.002 min.
S-10	1/10 sec.	1000 sec.	±.02 sec.
S-6	1/1000 min.	10 min.	±.0002 min
S-1	1/100 sec.	60 sec.	±.01 sec.
MST	1/1000 sec.	.360 sec.	±.001 sec.
MST-500	1/1000 sec.	30 sec.	±.002 sec.

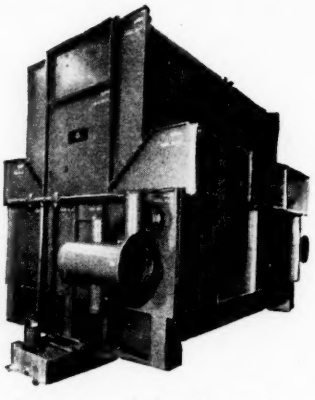
REQUEST BULLETIN NO. 198

THE STANDARD ELECTRIC TIME COMPANY

89 LOGAN STREET • SPRINGFIELD, MASSACHUSETTS

For more information circle **107** on inquiry card.

ECONOMICAL COOLING OF GASES AND COMPRESSED AIR



Cooling gases or cooling and removing moisture from compressed air, the Niagara *Aero* After Cooler offers the most economical and trustworthy method. Cooling by evaporation in a closed system, it brings the gas or compressed air to a point below the ambient temperature, effectively preventing further condensation of moisture in the air lines. It is a self-contained system, independent of any large cooling water supply, solving the problems of water supply and disposal.

Cooling-water savings and power-cost savings in operation return your equipment costs in less than two years. New sectional design reduces the first cost, saves you much money in freight, installation labor and upkeep. Niagara *Aero* After Cooler systems have proven most successful in large plant power and process installations and in air and gas liquefaction applications.

Write for Descriptive Bulletin 130.

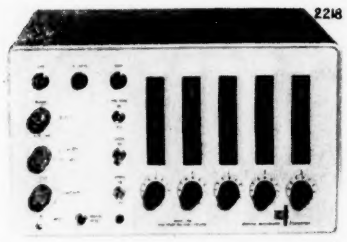
NIAGARA BLOWER COMPANY

Dept. IN-5, 405 Lexington Ave., New York 17, N.Y.

Niagara District Engineers in Principal Cities of U. S. and Canada

For more information circle **108** on inquiry card.

NEW INSTRUMENTS

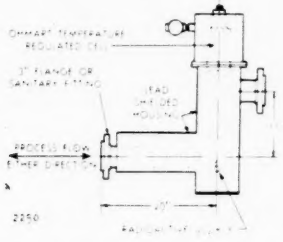


1 and 40,000 cps can be selected in 1-cps increments. Measurement is indicated by decades; also by three lamps: two red lamps marked LOW *and* HIGH and a green lamp marked IN LIMITS. Relay contact closure for external control is available for each lamp condition.—*Computer-Measurements Corp., 5528 Vineland Ave., N. Hollywood, Calif.*

For more information circle **525** on inquiry card.

FLUID DENSITY GAGE

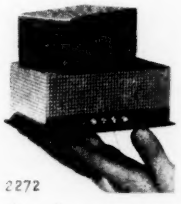
New Model ASR-3 measures density, specific gravity, or percent solids in a liquid continuously and



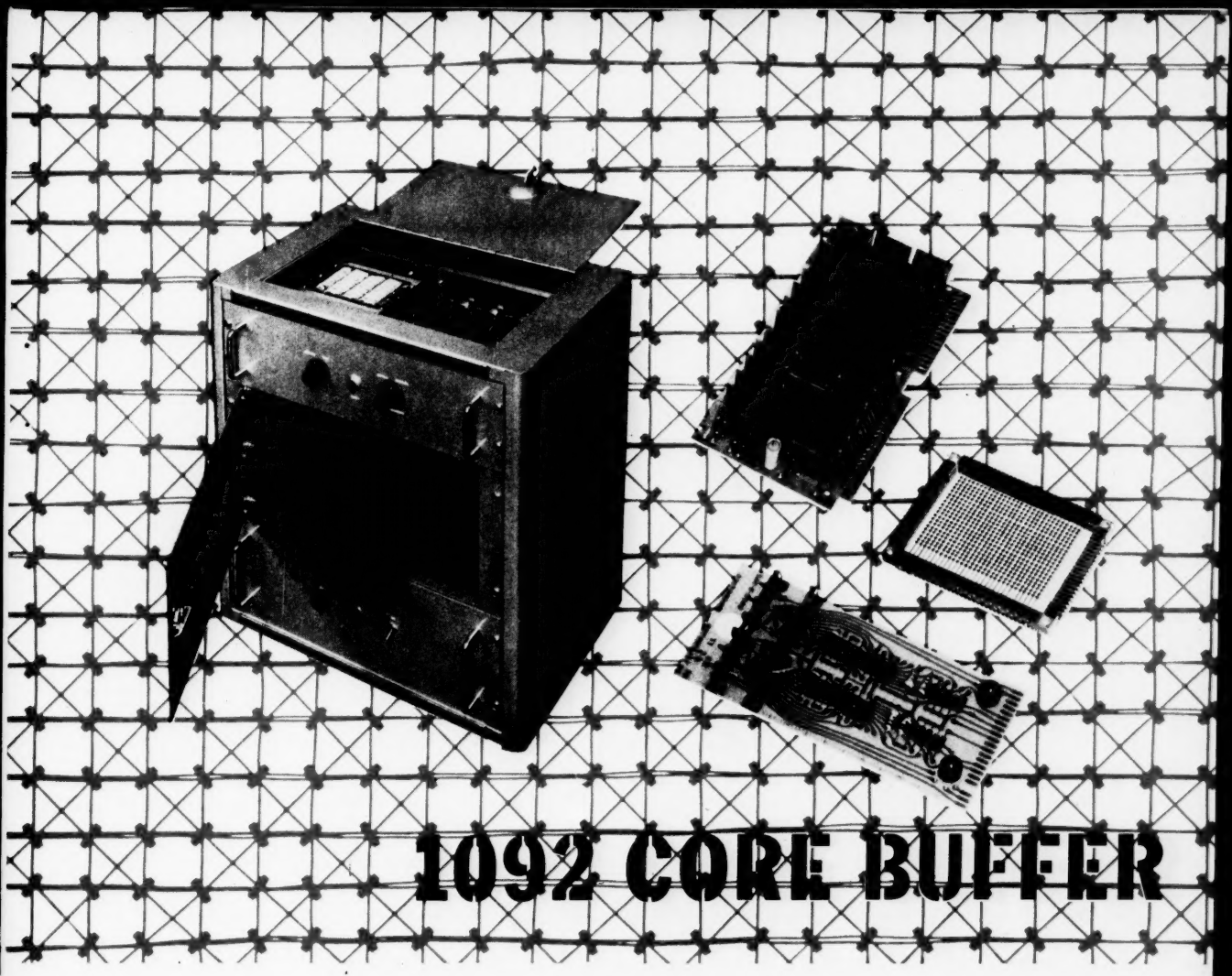
automatically with full-scale range as narrow as 0.05 sp gr units (7° Bé, 10 Tw, 20° API, 10% solids) with a precision of 2% of range; is designed for use with small-diameter pipes. There being no moving parts and no contact with material being measured, gage is not affected by flow, turbulence, viscosity, abrasion or agglomeration. Gage output signals can command valves, pumps, heaters, etc., to control density variable in flow processing.—*The Ohmart Corp., 2236 Boggen St., Cincinnati 14, Ohio.*

For more information circle **526** on inquiry card.

REMOTE CONTROL SYSTEM



New Ra-Trol is said to be the first completely transistorized subminiature electronic control system for gates, blast-furnace doors, freight-car grain unloaders, etc.; far surpasses vacuum-tube system through use of transistors, printed circuits, hermetically-sealed JAN-ized components, quartz-crystal



1092 CORE BUFFER

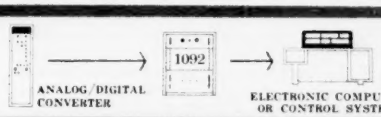
FOR BETTER BALANCED DATA HANDLING Two data systems of different operating characteristics can bog down your processing time, run up costs. Solution: make them compatible by using Telemeter Magnetics' 1092 Core Buffer, a completely transistorized buffer storage unit that synchronizes the major elements of differing digital systems. TMI, a pioneer in the development and manufacture of magnetic core storage buffers, has designed the Series 1092 to accept up to 1,092 eight bit characters and introduce them into storage with instant availability for output in the sequence previously loaded. Minimum loading or unloading time is 10 microseconds per character. Components are mounted on printed circuit plug-in cards. Contact a TMI representative, a specialist in the technology of magnetic core storage... by writing for complete details.

0/1 TELEMETER MAGNETICS *Inc.*

IA5, 2245 PONTIUS, LOS ANGELES, CALIFORNIA

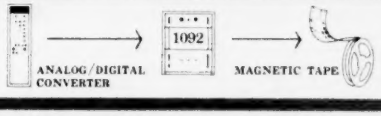
1092 Core Buffers can be put to work in many unusual applications... here are three which are typical:

ON-LINE DATA REDUCTION: Digitized test data are stored in the buffer until called for by the computer. On command, data move instantly into the computer memory.



DATA TRANSMISSION Data are temporarily stored in the buffer at receiving and transmitting terminals to provide suitable speed synchronization between the link and data handling equipment.

RECORDING OF CONTINUOUS TEST DATA: Test readings are digitized and stored in the buffer so that a complete data block may be recorded on magnetic tape in the desired computer format.

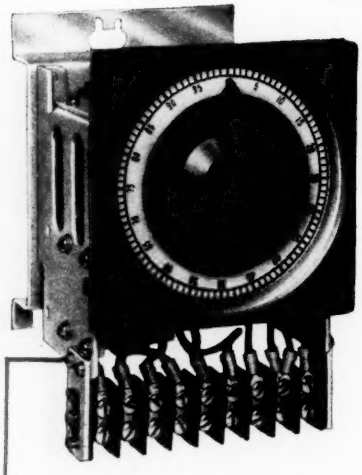


Job opportunities available for design engineers, applications engineers, and physicists.

0/1

For more information circle **109** on inquiry card.

Specifications



Dial — 1-99 Counts, adjustable

Speed — 400 counts per coil per minute maximum for intermittent use

Switch rating — 10 amps, 115 volts AC
Maximum Inrush
30 amps — Terminals 4-5
7-8
15 amps — Terminals 4-6
7-9

Coils — Continuous duty solenoids — Inrush current .9 amperes, 115 volt, 60 cycle

Life — Laboratory tests indicate an average of 5 million pulses on each count coil without maintenance

NEW! ... Eagle Signal announces development of special precision *ADD-SUBTRACT COUNTER*

A special new add-subtract counter has been announced by the Eagle Signal Corporation. (see complete specifications above) The basic function of the new device is to automatically control the number of units in a given area — thus simplifying inventory, stocking, and shipping problems.

Of extreme importance in materials handling operations, the new counter can be used in many and varied applications. For example, note Figure 1, a parking lot diagram, and Figure 2, a materials handling operation.

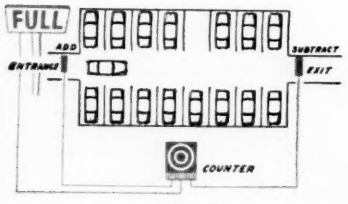


FIG. 1

In this parking lot, the counter is set for 16 vehicles, maximum. As the sixteenth vehicle enters, the counter relays an add pulse, and the "full" sign flashes on. When a car leaves, the counter will relay a subtract pulse, and the light will go out.

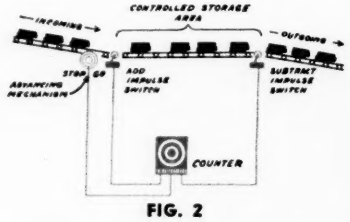


FIG. 2

In this application, a precise check is kept on inventory. No component enters or leaves the controlled storage area without registration by the add-subtract counter.

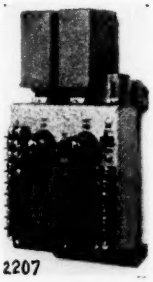
Where can you use the add-subtract counter? It will pay you to investigate this new product further, whether for built-in use in your product, or direct application. Eagle Signal engineers are ready with application assistance. Write now for more information, Bulletin 740, Eagle Signal Corporation, Dept. IA-558, Moline, Illinois.

For more information circle **110** on inquiry card.

frequency stabilization and extremely low operating voltages. Forty channels available. Normal control range 100 ft. (adjustments for up to ¼ mile).—*D. W. Thomas Engineering, Inc., 806 So. Robertson Blvd., Los Angeles 36, Calif.*

For more information circle **527** on inquiry card.

CONTROL RELAY FOR LVDTs



New Atcotran Electronic Control Relay is designed for operation with a transmitter using an Atcotran differential transformer for measuring pressure, motion, flow, force, level, weight, position, thickness, width, vacuum, etc. Its null position is sensitive to <0.0001". —*Automatic Timing & Controls, Inc., King of Prussia, Penna.*

For more information circle **528** on inquiry card.

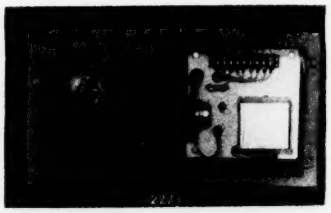
CHROMATOGRAPHY CELL

New CDC-1 thermal conductivity cell, specifically designed for vapor phase chromatography, employs thermistors as sensory elements; can be incorporated into existing apparatus; operates to 240°C; features small internal volume, fast response and convenient mounting. Series 3000 and 6500 cells require 7.5 and 12 vdc respectively, at 3-22 ma.—*Largent Co., P.O. Box 9845, Houston 15, Texas.*

For more information circle **529** on inquiry card.

PUNCH PRESS CONTROL

New inexpensive Punch Press Double-Stop Control prevents shut-down time on high-speed (up to 450 spm)



automatic and semi-automatic punch presses; protects against damage to presses and dies. If a "double" is fed into die or if a piece is unusually hard or thick, control disengages clutch and permits operator to remove troublesome piece before damage has been done. Operating voltage 110, 220 or 440; control range 1.5, 10, 20 or 100 amp. Time delay device bypasses initial surge.—*Tipptronic, Inc., Dept. PP, Chagrin Falls, Ohio.*

For more information circle **530** on inquiry card.

w-h-e-n

When can a firm manufacturing instruments for temperature, pressure and humidity be the best, if not the biggest in the field?

When is it possible for such an organization to produce the widest and most complete line of indicating and recording instruments available today?

When can you be sure that the instrument you buy, whether a simple thermometer or pressure gauge, or a complex recording unit, is the finest in its price range?

When can you know that promised delivery dates will be kept?

When it's WEKSLER! The reasons are factual and clear: Intensive specialization... modern plant with superior facilities...finest employee relations in the business...a continuing program of research and development... 100% inspection of virtually every item in the line?

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General Purpose Thermometers
Laboratory Thermometers
Industrial Liquid-in-Glass Thermometers
Dial Indicating Thermometers
Pressure Gauges
Recording Temperature, Pressure and Humidity Instruments
Hydrometers

WEKSLER INSTRUMENTS
WEKSLER INSTRUMENTS CORP.
FREEPORT, L. I., NEW YORK

For more information circle **111** on inquiry card.

temperature

STEPLESS HEAT CONTROL

New Model 215 Robotemp controls temperature by varying integrated input wattage; is much less expensive than a motor timer, yet can control up to 1500 watts.—*George Ulanet Co.*, 413 *Market St., Newark* 5, *N. J.*

For more information circle **531** on inquiry card.

HEAVY DUTY THERMOSTAT

New Klixon 20500 Series meets special requirements of clothes dryer industry for sp-dt thermostat with heavy-duty (3-amp) electrical rating; also for combination washer-dryers, electric heaters and fan motor controls.—*Spencer Thermostat Div., Metals & Controls Corp., Attleboro, Mass.*

For more information circle **532** on inquiry card.

LOW-COST INDICATING TEMPERATURE CONTROLLER

New Type E65N is offered in basic skeleton form (without enclosure) so that it can be incorporated directly, or designed into, equipment. Various ranges and several types of switches available.—*United Electric Controls Co.*, 79 *School St., Watertown, Mass.*

For more information circle **533** on inquiry card.

ROLL-TEMPERATURE TCs

New Roll Temperature Thermocouples feature fast response, easy installation, resistance to wear, no heat loss due to windage, temperature reading unaffected by changes in roll velocity, and constant bearing pressure of thermocouple assured by an internal spring. Choice of copper-Constantan, iron-Constantan or Chromel-Alumel.—*Conax Corp.*, 2300 *Walden Ave., Buffalo* 25, *N. Y.*

For more information circle **534** on inquiry card.

TEMPERATURE CONTROLLER

New Electronic Temperature Control Box houses components for a pulse-modulated high-limit tempera-

FOR...
Slip-On Insulation, Instrument Tubing, Bundle Sheathing, Medical Tubing, Pigtails...

USE PF SPAGHETTI SLEEVING
MADE FROM
TEFLON*

PF Spaghetti sleeving has these important advantages:

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2. Excellent electrical properties at high temperatures (500°F) and a wide frequency range
3. Low coefficient of friction. It slips on easily in long lengths of wire up to 3 ft.
4. Eliminates the need for silver coated wire
5. Zero moisture absorption
6. Unaffected by any commercial chemical
7. Stress relieved for negligible shrinkage

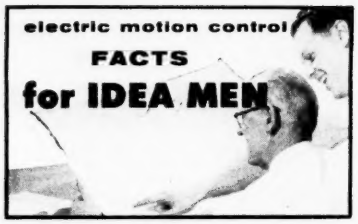
25 sizes, 2 wall thicknesses, 10 colors in stock, 100% inspected and controlled dimensionally are available.

Write, wire or call for full details, competent engineering assistance and information on special sizes and walls. PF Teflon* flexible tubing, heavy-walled tubing and rod stock are also available.

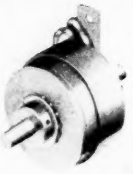
PENNSYLVANIA FLUOROCARBON CO., INC.
1115 N. 38th Street, Phila. 4, Pa. EVergreen 6-0603

*Teflon—DuPont trade name for Tetrafluoroethylene resin

For more information circle **112** on inquiry card.

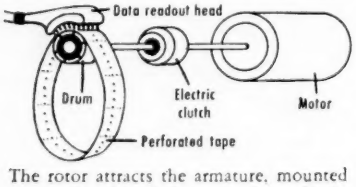


Electric clutch provides quick-acting power link for tape-indexing drum



PROBLEM: To index a feed drum one frame of ten lines so a readout head with wire-mesh fingers can detect 80 signals simultaneously from tape perforations. Fingers drop through perforations and contact the silver-plated drum, supplying 60 to 100 bits per step for rapid readout.

Power is from a continuously running motor through a Warner stationary-field electric clutch-coupling. An electronic control unit energizes the clutch field with a 10-millisecond pulse for each 60-deg index. When the clutch is energized, flux flows from the field (stationary-mounted) to the rotor, which is keyed to the drive shaft.



The rotor attracts the armature, mounted on a spline-drive hub to the driven shaft, powering the paper feed drum. Drum rotation never reaches motor speed. Driving occurs in a slipping condition.

Completes 60° index in 30 ms

The Warner clutch is in the plate circuit of a type 6BG6 tube and is energized for about 10 ms. Parts are accelerated for about 9.5 ms at a torque of about 8 in.-lb. The drum reaches 490 rpm max. for each index.

To build up current in the clutch field, engage the armature and rotor, and start rotation of the drum, requires only .5 ms.

Friction in the clutch is between the rotor and the armature, either of which can be replaced in a few minutes without disturbing the electrical connections. The armature floats axially on a splined hub, providing automatic wear take-up.

Want more IDEAS?

Send for factual application sheets showing how machines are made more profitable, easier to control, simpler to maintain with *electric motion control* drives. Write to:

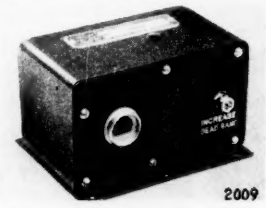
Industrial Products Division
Warner Electric Brake & Clutch Co.
Beloit, Wisconsin

WARNER

Beat competition with ELECTRIC BRAKES AND CLUTCHES

For more information circle **113** on inquiry card.

NEW INSTRUMENTS



ture control system. Compact amplifier, subminiature tubes, and high-quality relays make controller insensitive to shock and vibration to 10 *G* without special mounts. Preamplifier tubes are selected and placed with care to minimize bulb and tube element temperature rise. —*Barber-Colman Co.*, 1400 *Rock St., Rockford, Ill.*

For more information circle **535** on inquiry card.

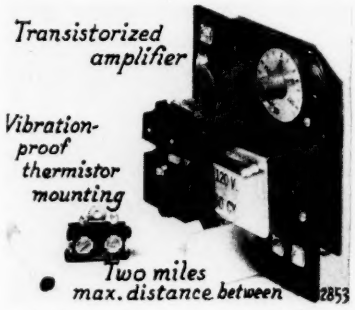
TEMPERATURE CONTROLLERS

New Temperature Monitors can control any temperature from −400°F to 3000°F; are ready to connect to thermocouples and source of power. Each contains a sensitive meter-relay and 5-amp load relay, with transformer and rectifier or other components for type of control required. Control action can be on-and-off for maintaining a set temperature; or limit with external reset.—*Assembly Products, Inc., San Gorcinto Div., P. O. Box XX, Palm Springs, Calif.*

For more information circle **536** on inquiry card.

TEMPERATURE CONTROLLER

New R7079A Transistorized Amplifier Relay System, said to be "the world's most versatile temperature



controller," features use of thermistors as primary elements, in shock-proof mountings. Amplifier relays are available in eight overlapping ranges of about 100 F° each to permit control from −60°F to 520°F. Control point stability: shift of ≤1F° for every 70F° change in ambient temperature. One amplifier relay can be used with various primary elements. Wiring between primary element and relay need not be shielded since bridge circuit is dc-powered.—*Minneapolis-Honeywell, Control Device Div.*, 2747 *Fourth Ave. So., Minneapolis, Minn.*

For more information circle **537** on inquiry card.

position, vibration, acceleration

DISPLACEMENT PICKUP

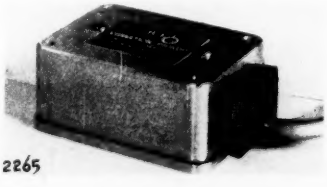
New differential transformer has ceramic bobbin wound with Teflon-insulated wire and encased in stainless

steel shell. Sensitivity 0.25 mv output per 0.001" displacement per volt input at 60 cps; null voltage 0.1 mv; input 1.5 v, 60 cps.—*Automatic Timing & Controls, Inc., King of Prussia, Penna.*

For more information circle **538** on inquiry card.

VIBRATION PICKUPS

New TD Series vibration pickups, thanks to a unique magnetic circuit,

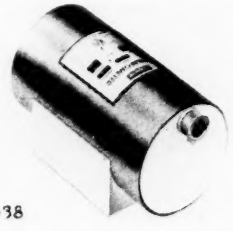


combine temperature stability of magnetic damping with sensitivity previously available only in fluid-damped units: over 300 mv/in/sec. Five models, with natural frequencies from 1.8 to 5.6 cps; response to 2500 cps on undamped and 1500 cps on damped units. Weight 9 oz.—*Southwestern Industrial Electronics Co.*, 2831 *Post Oak Rd., Houston* 19, *Texas.*

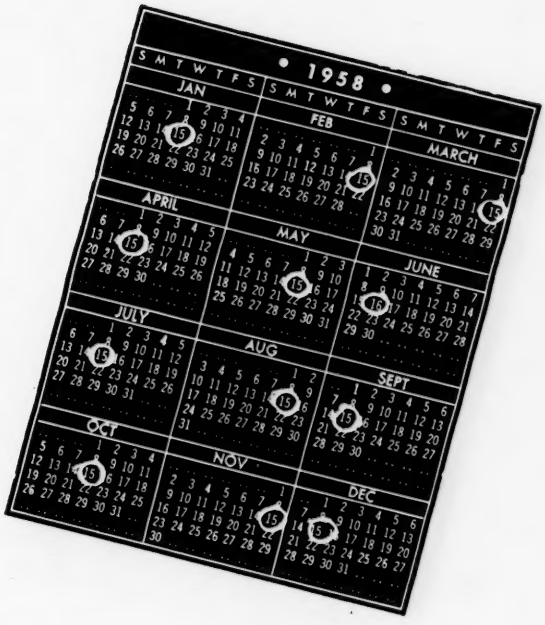
For more information circle **539** on inquiry card.

ACCELERATION PICKUP

New Model 24614 AC Accelerometer features low threshold and wide dynamic range; yields a 10-mv out-



put change for accelerations of about 0.0017 G; is available in various low natural frequencies, and in ranges



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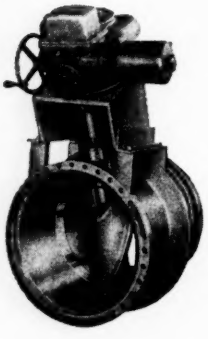
ROCKWELL VALVES

like these

"Kwikleen" slide valve for powdered coal, granular materials, flue gases with high solids content, etc.; solids accumulations easily cleaned out by removing bottom plate.



"Stress-seal" butterfly valve for tight shut-off of hot, corrosive or dirty gases to 1300° F. and higher, at 200 p.s.i. Alloy stress band in valve body is inflated by external gas pressure to effect tight seal.

Butterfly valve with simplified bracket and linkage to air operator and valve disc positioner; provides maximum adjustment, minimizes friction, eliminates backlash, chatter and hunting, reduces power requirement in close control applications.

"Slim-Jim" wafer type butterfly valve for low pressure air, gas or liquids; low cost, light, simple, space-saving, easy to install.

What's your valve problem?

W. S. ROCKWELL COMPANY
2128 ELIOT STREET
FAIRFIELD, CONN.

For more information circle **115** on inquiry card.

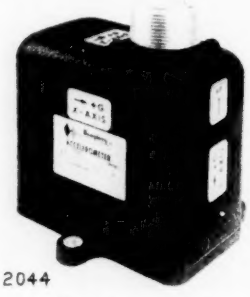
NEW INSTRUMENTS

from ±1G to ±20G. Its ac output is accurately proportional to linear acceleration parallel to its mounting base.—*G. M. Giannini & Co., Inc.*, 918 *E. Green St., Pasadena 1, Calif.*

For more information circle **540** on inquiry card.

ACCELERATION PICKUP

New Three-Axis Accelerometer combines three miniature linear acceleration pickups into one compact



unit weighing about 1 lb, requiring only one input and only one connector. Available ranges from ±1G to ±70G (or asymmetrical ranges in any desired combination). Accuracy 1% to 2%, depending on range.—*Humphrey, Inc.*, 2805 *Canon St., San Diego, Calif.*

For more information circle **541** on inquiry card.

flow-rate and volume

AIRSPEED & STATIC PRESSURE INDICATOR

New No. 460 Air Meter gives direct readings for furnace draft, pressure drop across air filters, duct air velocity, etc. Two velocity ranges: 260 to 1200 fpm and 1000 to 4000 fpm. Static pressure ranges 0.005" to 0.09" water and 0.05" to 1.0" water.—*F. W. Dwyer Mfg. Co., P. O. Box 373, Michigan City, Ind.*

For more information circle **542** on inquiry card.

FLOW-RATE INDICATOR

New Type 7, for use with Cox or other turbine flowmeters producing frequency output proportional to flow-rate, features 1% accuracy; requires no accessory equipment; is available for

The man who KNOWS— Knows where to LOOK—

And a more complete personal or company library assures easy accessibility to reference sources which can enhance your knowledge. Each of the books listed below is a "must" for the instrumentation library.

100 Electronic Circuits

by M. H. Aronson and C. F. Kezer . . . . covers amplifiers, oscillators, pulse circuits, phototube circuits, phase shifters, etc. Complete with all circuit component values and response specifications.

paper, 180 pages, illustrated ..Price $2.00

The Automatic Factory

by Jung, Bardis, Lurio, Polaner, Sassenfeld, Sklenar and Yenken. Here is THE book for all who want FACTS rather than wild opinions . . . a fresh viewpoint on what "manless factories" CAN be—a book free from the generalities, platitudes, exaggerations and misconceptions repeated by many writers on this subject. 1955.

cloth, 88 pages, illustrated ....Price $1.50

Process Control

by A. J. Young, Head of the Central Instrument Laboratory, Imperial Chemical Industries, Ltd.

". . . a MUST for all men who have to do with the automatic control of industrial processes; combines the practical "how" and the theoretical "why." 1955.

cloth, 134 pages, illustrated ..Price $2.00

Heat Inertia Problems of Automatic Control of Temperature

by Victor Broida, based on the concept of "fictitious mass" of heating process unit under automatic control. 1950.

paper, 5¼" x 8¼", 61 pages Price $1.00

Applications of Industrial pH Controls

by Allen L. Chaplin. 1950.

cloth, 4½" x 8", 144 pages ..Price $2.00

Operation and Care of Circular-Scale Instruments

by James Spencer, profusely illustrated with circuit diagrams, schematic diagrams, and photographs. 1949.

cloth 4 ½" x 8", 90 pages ....Price $1.50

Process Control Analysis

by Millard H. LaJoy and E. Allen Baillif." . . . an essential first step in analysis of closed-loop controlled processes via frequency response of the system." 1956.

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Instruments Publishing Co.
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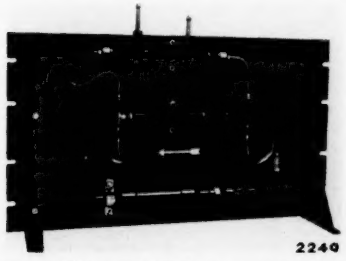
Pittsburgh 12, Pa.

volumetric or gravimetric measurements. (Specific gravity adjustment is built into units calibrated in gravimetric units.)—*Cox Instruments Div., George L. Nankervis Co.*, 15300 *Fullerton Ave., Detroit* 27, *Mich.*

For more information circle **543** on inquiry card.

1000 : 1 RANGE FLOWMETERS

New ER (extended range) Series linear primary flow element assemblies make possible gas flowmetering



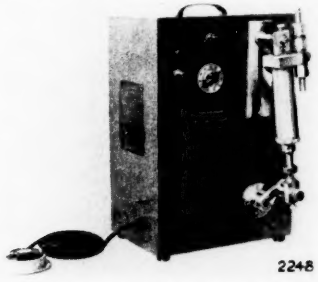
2240

rangeability of 1000 to 1. Assembly shown has total flow ranges of 3, 0.3, and 0.03 fcm. Available for flows up to 300 cfm for most gases. Primary elements for either 10" or 25" water d/p.—*National Instrument Labs., Inc.*, 828 *Evarts St., N. E., Washington, D. C.*

For more information circle **544** on inquiry card.

RECYCLING ATTACHMENT FOR LIQUID FILLER

New Multi-Fill recycling attachment permits containers up to 1-gal to be filled with Filamatic filling



2248

machine, or an entire case of bottles to be filled at one time. By attaching a switch to a conveyor, user can provide a semi-automatic liquid filler at low cost.—*National Instrument Co., Baltimore* 15, *Md.*

For more information circle **545** on inquiry card.

pressure and vacuum

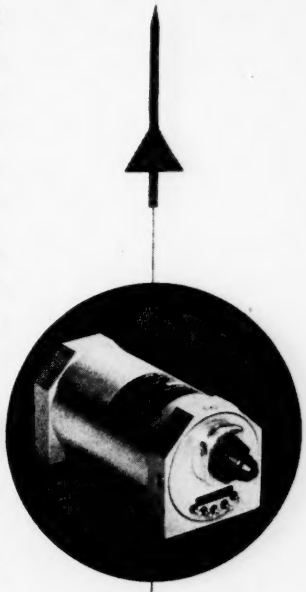
NON-METAL-CASE GAGE

New 4½" dial pressure gage utilizes a safety solid-front case made of phenolic resin with a rag content of about 50%. Case strength is comparable to cast iron for field applications. Solid-front case feature offers complete safety to viewer in event of

If you want

Accuracy •
Vibration Resistance •
Acceleration Resistance •
High Output •
Small Size •

in a pressure pickup for flight control or guidance applications then you want



WIANCKO'S *new* **P3400**

This advanced pressure pickup has been designed expressly for guidance and flight control of aircraft and missiles. Its basic design has been used in thousands of Wiancko pickups, but refinements have made the P3400 the finest achievement of more than 11 years of continuous research and experience. The P3400 may be what you are looking for. Here are some reasons why:

Linearity: 0.5% of pressure span or less
Hysteresis: 0.1% of pressure or less
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Vibration: 25 g, up to 2000 cps
Acceleration: 50 g
Temperature: −65 F to +200 F
Output: 0.10 volt/volt ±2% over total pressure range
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Write for Product Bulletin 102.

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For more information circle **116** on inquiry card.

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For more information circle **118** on inquiry card.

NEW INSTRUMENTS

tube rupture. Weather-tight full-area blowout disc can be removed to expose entire gage mechanism. Tube materials: bronze, alloy steel, stainless steel or Monel.—*Norden-Ketay Corp., Milford, Conn.*

For more information circle **546** on inquiry card.

RAM-FORCE GAGE

New Total Pressure Gage directly reads total pressure of ram-on-work in presses, etc. Pressure is applied to two flat parallel surfaces (either vertical or horizontal). Three capacities: 10,000, 20,000 and 100,000 lb; others on application.—*Studebaker Hydraulic Products Co., 1733 N. 33rd Ave., Melrose Park, Ill.*

For more information circle **547** on inquiry card.

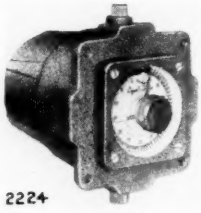
HIGH-VACUUM PUMP

New VacIon operates electronically (no moving parts) to produce "a more effective vacuum than any other known commercial device": in excess of 10^{-9} mm Hg; operates in a closed system utilizing electronic principles to ionize and remove gas molecules. No need of refrigeration systems, cold traps or vapor traps. Pumping speed of 10 l/sec @ 10^{-7} mm Mg. Microammeter continuously indicates vacuum.—*Varian Associates, Palo Alto, Calif.*

For more information circle **548** on inquiry card.

time, sequence, speed, counting

RESET TIMER



New reset timer for applications in hazardous areas is contained in a NEMA VII explosion-proof housing designed for flush mounting; is available in time ranges from 10 sec to 10 hr in 115-v or 230-v models. Contact rating 10 amp. Up to 4 load circuits available for external functions.—*Eagle Signal Corp., Moline, Ill.*

For more information circle **549** on inquiry card.

AUTOMATIC TIMER

New Bulletin 820 miniature time delay relay uses a new escapement designed for reliable operation under aircraft and missile temperature, shock and vibration conditions. Its timing accuracy is not affected by voltage variations. Timing begins when the 28-vdc solenoid is energized; a 4-amp sp-dt switch is actuated at end of timing interval; mechanism resets in 0.05 sec. Timing ranges available from 1 to 15 sec.—*Eagle Signal Corp., Moline, Illinois.*

For more information circle **550** on inquiry card.

REPEAT CYCLE DIAL TIMER

New Series 306 Duo-Set miniature timer operates on reversible motor principle. Synchronous motor drives elapsed time indicator up-scale and downscale to setting pointers. Reversal is smooth, silent, self-synchronizing, without springs, solenoids, ratchets, pawls, etc. Timer controls two independently-adjusted load circuits for OFF-ON cycling over entire dial range without limitation of setting anywhere within timer range.—*Automatic Timing & Controls, Inc., King of Prussia, Pa.*

For more information circle **551** on inquiry card.

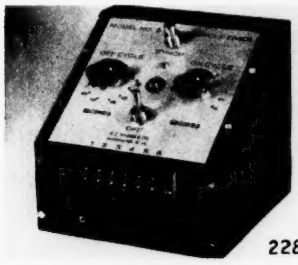
AUTOMATIC TIMERS

New transistorized timers feature advanced *RC* circuitry which permits intervals ranging from 50 milliseconds to several hours and obviates use of motor-driven and thermal elements. Voltage ranges 14 to 32 vdc or 24 to 220 vac. Timers can withstand temperatures to 125°C and meet MIL shock and vibration specs.—*Jordan Electronics Div., The Victoreen Instrument Co., 3025 W. Mission Rd., Alhambra, Calif.*

For more information circle **552** on inquiry card.

REPEAT CYCLE TIMER

New Model 5 Repeat Cycle Timer has OFF cycle adjustable in 12 steps from 1 to 300 sec; ON cycle adjust-



2288

able continuously from 0.1 to 10 seconds. Output is dp-dt relay with 15-amp contacts.—*G. C. Wilson & Co., Huntington, W. Va.*

For more information circle **553** on inquiry card.

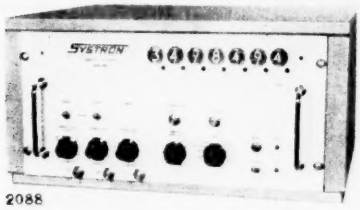
HIGH-TEMP SERVOMOTOR TACH

New Type 18-MTG 6302 servomotor tach exceeds BuOrd Mark 16 specs with operating temperature range from −54°C to 125°C and starting voltage as low as 1.5; consits of 115-v 400-cps 2-phase size 18 servomotor with a precision size 15 tachogenerator integrally mounted on motor shaft. Output 3.1 v per 1000 rpm linear within 0.2% up to 5400 rpm.—*John Oster Mfg. Co., Avionic Div., 1 Main St., Racine, Wis.*

For more information circle **554** on inquiry card.

COUNTER-TIMER

New Model 1031 is said to be the first single-package in-line megacycle-microsecond counter-timer. It



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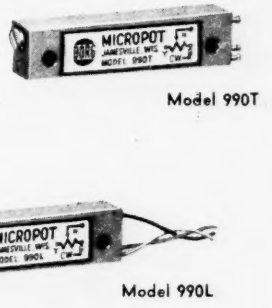
measures frequency to 1 Mc, time and period in 1-usec increments, phase angles in 0.1° increments, events to 7 digits, ratio of 2 frequencies; and it serves as a secondary frequency standard. Principal physical feature is numerals readable at 30 or 40 ft.—*Systron Corp., 2055 Concord Blvd., Concord, Calif.*

For more information circle **555** on inquiry card.

RATEMETER AND COUNTER

New Model WE-120 light-weight five-decade frequency or events-per-unit-time meter and electronic counter uses decade glow transfer tubes for both digital presentation and digital division of time-base frequency. Frequency range 10 to 100,000 cps; stability 0.001% plus

These little fellows do a Whale of a job...



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Borg 990 Series Trimming Micropots provide accurate voltage adjustments in critical electronic circuits. Extremely small, they fit readily into subminiature circuits. They are wire wound and adjustable. Borg Trimming Micropots are protected against humidity, salt-spray, dust and other adverse environmental conditions. They can be mounted individually or stacked to give the designer the greatest possible latitude. Borg 990 Series Trimming Micropots are available with three types of terminals . . . printed circuit, soldered lug and insulated wire leads.

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For more information circle **119** on inquiry card.

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Accurate HIGH-SPEED Continuous Telemeter

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The Model 1025 Telemeter Transmitter converts DC mv from thermal converters, etc., to 10-30 cps which frequency modulates a built-in audio tone channel. AC 10 to 30 cps or relay outputs are also available. Receiver detects and demodulates transmitted signal, generating a DC mv for operation of recorders or indicating instruments. Up to 45 telemeters can be multiplexed.

Any communication link, including power line carrier, microwave or wire line may be used.

Over-all accuracy is 1% with a response speed of 1 second. Equipment features a built-in calibration circuit for 10% and 90% receiver check, and 10 cps and 30 cps transmitter check.

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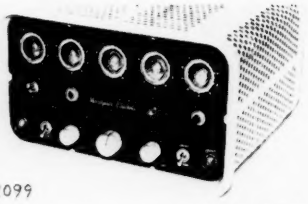
NEW INSTRUMENTS



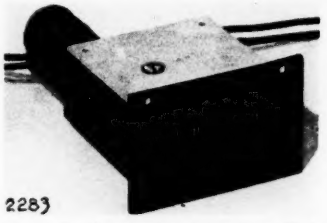
2099

or minus one count; variable display time from 0.5 to 5 sec and manual. External trigger input is provided for initiating start of counting cycle.—*Westport Electric* 149 *Lomita St., El Segundo, Calif.*

For more information circle **556** on inquiry card.

ELECTRIC COUNTERS

New Series 1591 compact panel-mounted instant-reset high-speed electrical counters fill gap between stand-



2283

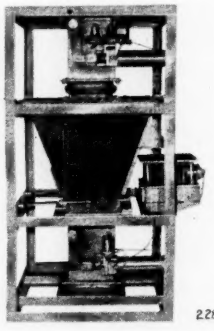
ard and electronic counters. Rated speed 3000 counts per minute but units have been tested at 6000 cpm for extended periods. Counter life expectancy exceed 200 million counts.—*Veeder-Root Inc., Hartford 2, Conn.*

For more information circle **557** on inquiry card.

weighing

HOPPER SCALE

New unitized weighing hopper scale gives new standardization and flexibility to automatic weighing systems;



2285

comprises three pre-engineered frames—feed, hopper and discharge—put together by building-block techniques. Feed and discharge frames accommodate various gate valves, slide gates, screw feeders, vibratory feeders, etc. Considerable economy is

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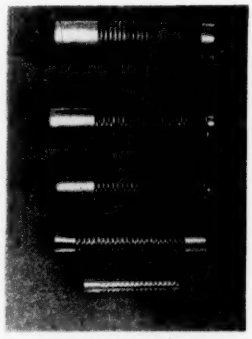

ACTUAL SIZES

TYPICAL BELLOWS: 0.250" O.D. 0.0012" wall 22 active convolutions 0.150" stroke 7 lbs./in. spring rate

Wall Thicknesses: Any value down to .0008"

Metal: The metal used is a Nickel alloy of high tensile strength with good spring properties. It is a bright, corrosion resistant metal, easily soldered or brazed with no precautions required as to flux.

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For more information circle **121** on inquiry card.

effected, and scales are readily adapted to present and future needs with little or no modification of existing system components. Standard hoppers have maximum capacities from 5 to 90 cu ft of material.—*Weighing & Control Components, Inc., 496 Lincoln Ave., Hatboro, Pa.*

For more information circle **558** on inquiry card.

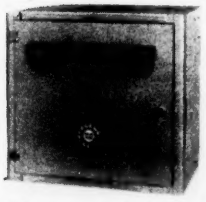
BATCHING SYSTEM

New Remocon batching system features (1) scale cutoffs remotely adjustable to desired weights by turning knobs on control panel without manual adjustment at scale itself; (2) provision for presetting several batch designs; (3) means of changing batch quantity without resetting individual ingredient weights; (4) provision for automatic weight recording; (5) Preact control to compensate for material between feeder and weigh hopper at cutoff.—*Toledo Scale Corp., Toledo 3, Ohio.*

For more information circle **559** on inquiry card.

telemetering

TELEMETERING DISPLAY



New In-Line reading for Varec Pulse Code Liquid Level & Temperature Telemetering Systems is available for users who prefer this type of data viewing. All figures are same size and intensity; numbers are clearly visible from an oblique angle.—*Vapor Recovery Systems Co., 2820 N. Alameda St., Compton, Calif.*

For more information circle **560** on inquiry card.

TRANSISTORIZED FM TELEMETERING TRANSMITTER

New Model TR-10 incorporates best features of transistors and vacuum tubes: all frequency-determining and low-level stages are transistorized to eliminate FM noise of tube elements

TOUGH
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Save SPACE
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The A. W. HAYDON COMPANY'S unique Line of
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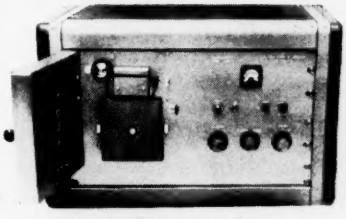
For more information circle **123** on inquiry card.

The Magneloop*



Continous-Loop
MAGNETIC TAPE RECORDER

Designed to record and playback signals of transients, program-controlled instructions and other data continuously or intermittently from 10 seconds to 60 minutes in duration. For automation, processing, or simulation this newly developed endless-loop recorder enables a pre-recorded pattern of action to be repeated indefinitely. The control of chemical, mechanical or electrical processes is made possible with accuracy and efficiency, since each repeated cycle is executed as originally recorded.

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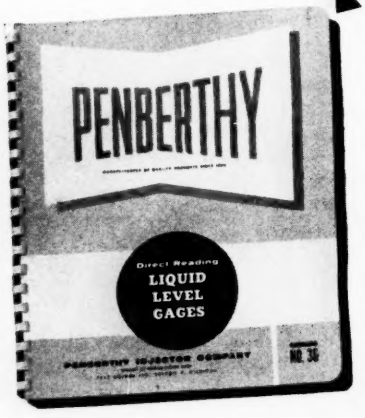

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COMPANY_____

For more information circle **125** on inquiry card.

NEW INSTRUMENTS

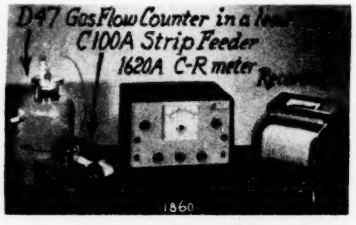
under vibration; rugged subminiature tubes are used in output stages. Unit is constructed for missile environment; accepts inputs from standard IRIG subcarrier oscillators (channels 1-18 and A-E); is crystal-stabilized and meets IRIG standards. Power output 2 watts in 215-245-Mc band. Dimensions 1¼ x 2⅝ x 4¼".—*United Electrodynamics, 1200 S. Marengo Ave., Pasadena, Calif.*

For more information circle **561** on inquiry card.

nucleonics

AUTOMATIC SCANNING SYSTEM FOR RADIO-CHROMATOGRAPHY

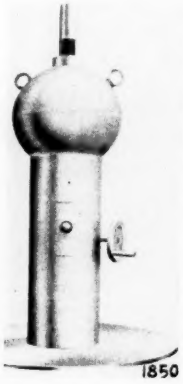
New Actigraph II is a completely new system for automatic scanning of paper radio-chromatograms. It



scans, counts, and records automatically the radioactivity distributed on a strip radio-chromatogram; features continuous scanning free from operator attention.—*Nuclear-Chicago, 229 W. Erie St., Chicago 10, Ill.*

For more information circle **562** on inquiry card.

GAMMA SOURCES



New Nucor Hero Series high-flux gamma irradiators, for applications from 600 r/hr to 3 × 10^6 r/hr and higher, are safe and economical, with welded steel case and such low surface flux that they can be used in any office or lab without special construction or connections.—*Isotopes Specialties Co., 170 W. Providencia, Burbank, Calif.*

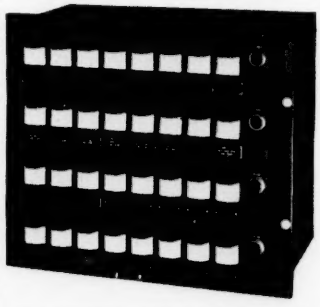
For more information circle **563** on inquiry card.

MULTIPLE-USE SCALER

New Model 132 Multiscaler II is a general-purpose high-speed glow-tube scaler featuring universal high-speed counting for use in medical and in-

ANNUNCIATORS and Accessories

Imagineered by TEL-ALARM



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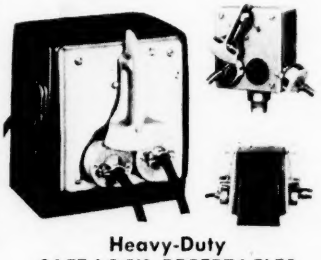
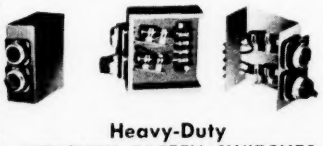
Hermetically-sealed
General purpose
Explosion-proof

- Backlighted Name Plates
- Turret Lenses
- Bull's eye



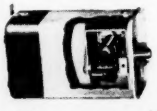
Heavy-Duty SAFE-LOCK RECEPTACLES

For hazardous and explosive areas . . . and all general purpose applications.



Heavy-Duty MERCURY SAFETY SWITCHES

For hazardous and corrosive atmospheres and all general purpose applications.



MOTOR DRIVEN FLASHERS

with mercury switch interrupters

Write for Descriptive Bulletins

Tigerman Engineering COMPANY
4332 North Western Avenue
Chicago 18, Illinois

For more information circle **126** on inquiry card.

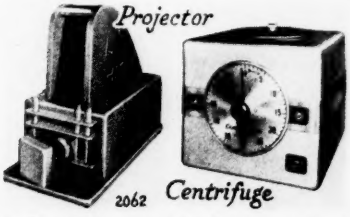
dustrial research; provides extreme versatility for geiger, proportional and scintillation counting. Containing a high voltage power supply, it can be used with any preamplifier-detector combination to form a complete counting system. It utilizes all-electronic Dekatron cold-cathode glow tubes for direct count readout, and has capabilities of both elapsed and preset time. Wide range of pulse height selection.—*Baird-Atomic, Inc., 33 University Rd., Cambridge 38, Mass.*

For more information circle **564** on inquiry card.

lab equipment

PARTICLE SIZE ANALYZER

New general-purpose instrument for measuring size distribution of small particles at minimal cost was

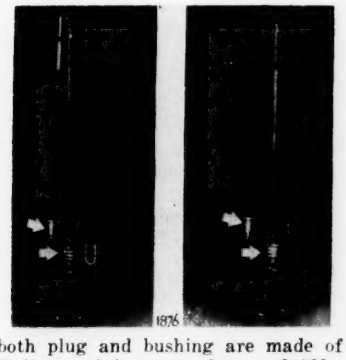


designed for particles between about 0.1 and 40 microns; comprises special centrifuge tubes and a tube feeding chamber, one or more special centrifuges, and an optical projector for measuring a magnified image of the sediment column in a centrifuge tube.—*Mine Safety Appliances Co., Pittsburgh 8, Pa.*

For more information circle **565** on inquiry card.

SEMI-AUTOMATIC BURETTES

New Geyomatic Burettes with automatic zero require no lubrication and prevent frozen connections because



both plug and bushing are made of Teflon and because of use of "No-Lub" process: special compound fused at high temperature to form a bearing permanently bonded to glass surface. Two styles: TJ-716 for acids; TJ-742 for alkali solutions.—*Scientific Glass Apparatus Co., Inc., Bloomfield, N. J.*

For more information circle **566** on inquiry card.

how many?

Marksman **RECORDERS by WEST**

Now in full production, these completely new tubeless potentiometer strip chart recorders are ready to go to work for you.

Get these features in all standard models at no extra cost:

- Transistorized Amplifier
- Printed Circuits
- Dial 5 Chart Speeds
- Chart Tearoff Strip
- Automatic Standardization
- Standardizing Indicating Light
- Built-in Chart Saver
- Plug-in Construction
- Separate Chart Re-Roll Motor
- Infinite Resolution Slide Wire
- Eleven Inch Calibrated Chart Width
- Will Mount in 19 Inch Relay Rack

Yours are ready! For data or demonstration, write for Bulletin M or phone your West representative listed in the Yellow Pages.

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Visit Us in Booth 426
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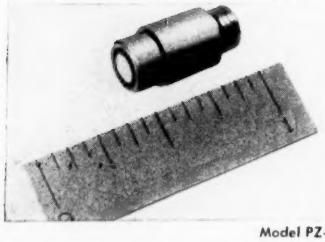
June 9 thru 13, 1958, in New York

For more information circle **127** on inquiry card.

NEW PRODUCT NEWS

Model PZ-14



Model PZ-6

Single Kistler Transducer Measures Pressures, Rates, Forces and Acceleration

Precise measurements of diverse pressures, pressure rates, differential pressures, forces, vibration and acceleration can now be made with one Kistler SLM Transducer.

Providing advanced instrumentation for engines, compressors, shock tubes, gun tubes, rockets, hydraulic and pneumatic systems, the self-generating, crystal-type *SLM Pressure Pickup (Model PZ-14)* performs as follows: Measures pressure or pressure rate *directly;* displays all pressures from full vacuum to 3000 psi (100,000 psi with adaptors); covers frequency range of 0 to 50,000 cps; operates continuously at 600° F; withstands intermittent gas temperatures to 3000° F; indicates .1 psi variations at any pressure level to 3000 psi; measures fast pressure transients; makes short term measurements of static pressures. The *SLM Miniature Pickup (Model PZ-6)*, of the same basic design as the *PZ-14 Pickup*, achieves response times approaching one microsecond.

Transient differential pressures can be measured precisely at distant points by using two SLM Pressure Pickups opposite polarity. When pickup cables are joined, signals automatically add or subtract. An Accelerometer Adaptor with a mass, spring-loaded against the crystals, converts the standard SLM Pickup into a precision *Acceleration-Vibration Indicator.* Static calibration is accomplished by turning it upside down in the earth's gravity field, generating a 2G signal.

Utilizing a *Force Adaptor*, the SLM Pickup precisely measures forces to 300 lbs. with less than .005" deflection, and .1 lb. variations at any level. Larger forces may be accommodated by using several pickups with their signal leads joined.

SLM Pickups are coupled to oscilloscopes or recorders with electrostatic amplifiers *e.g.* Kistler Piezo-Calibrator-Amplifier units. A new Amplifier-Calibrator (Model PT-14), single or two-channel rack mounted, has fast response (0 to 200,000 cps), high gain (20), and low output impedance (7000 ohms). For complete information, request Bulletin S-114.

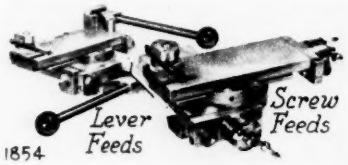
Kistler Instrument Corp., Dept. IA, 15 Webster St., North Tonawanda, N. Y.

For more information circle **128** on inquiry card.

shop equipment

SLIDE REST

New heavy-duty compound slide rest fits all standard jewelers' type instrument lathes. Among features:



1"-dia lead-screw dials with non-glare finish; swivel slide locked with two tee-bolts will hold securely under any strain; both slides fitted with micrometer stops; new-design tool post obviates risk of breaking tee-slots.—*Louis Levin & Son, Inc., 3610 So. Broadway, Los Angeles 7, Calif.*

For more information circle **567** on inquiry card.

WIRE MARKER PACKAGE

New Maintenance Pac pocket-size carton, holding 25 cards of different Brady Perma-Code Vinyl-Cloth Wire

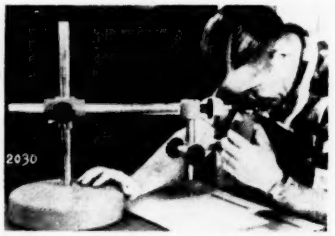
Markers, provides a ready supply of markers for original installations, rewiring, or maintenance work.—*W. H. Brady Co., 727 W. Glendale Ave., Milwaukee 9, Wis.*

For more information circle **568** on inquiry card.

inspection & gaging

STEREO MICROSCOPE

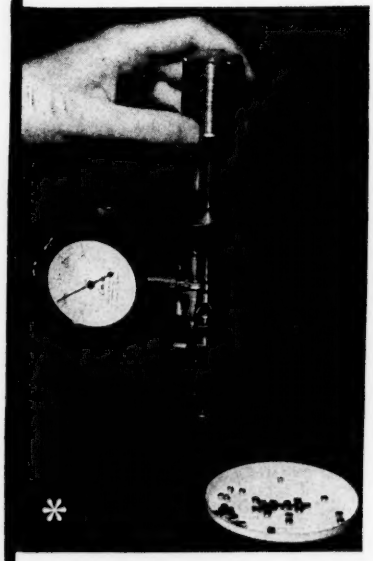
New stereo microscope on heavy base with long range extension arm is an American-made instrument pro-



viding up to 3" working distance; has two sets of objectives on a rotating turret. Standard pair of wide-field 10× Kellner eyepieces give 23 power and 40 power.—*Edmund Scientific Co., Barrington, N. J.*

For more information circle **569** on inquiry card.

There's a *Bird*
JEWEL BEARING
to fit Your Need!



Bird can supply you with sapphire and borrosilicate glass precision jewel bearings in a wide range of standard types, sizes, and complete assemblies — or, custom-built to your specifications. Special mounting techniques provide exact tolerance jewel assemblies, mounted or set in bushings or screws, ready for assembling into your product without further inspection. Jewels mounted with resilient silicone rubber or spring cushions provide additional protection to shock and vibration.

Because of the exact tolerances, maintained through the most rigid quality-control methods, Bird jewels are used by the foremost manufacturers of electrical, aircraft, and timing instruments — and recorders.

Typical products include:

Aircraft Instruments
Weather Recorders
Ammeters
Voltmeters
Wattmeters
Compasses
Dial Gages
Timers
Test & Recording Instruments
Marine Instruments

**Illustrated — Concentricity check of mounted ring jewels — one of the inspection processes in Bird's quality control program.*

Our engineering staff is at your service for all small bearing problems. A request on your letterhead for Bulletin 100-6 will receive our prompt attention.

Richard H. Bird & CO., INC.

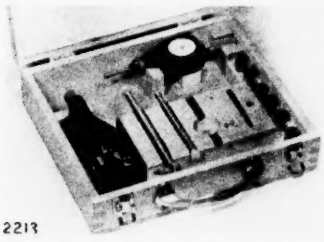
1 SPRUCE ST., WALTHAM 54, MASS.

SAPPHIRE & GLASS JEWELS
PRECISION GLASS GRINDING
JEWEL MOUNTING & ASSEMBLY

For more information circle **129** on inquiry card.

DIAL BORE GAGE KIT

New 2/0 bore gage, added to Trio-set kit, with use of extensions covers a range of 0.084" to 0.125". Complete



2213

kit is said to have less than half the extensions required by most comparable kits and to cost less.—*Boice Gages, Inc., Hyde Park, N. Y.*

For more information circle **570** on inquiry card.

COATING-THICKNESS GAGE

New Model FLW-1 Glennite Laminagage, for non-destructive measurement of thickness of coatings and

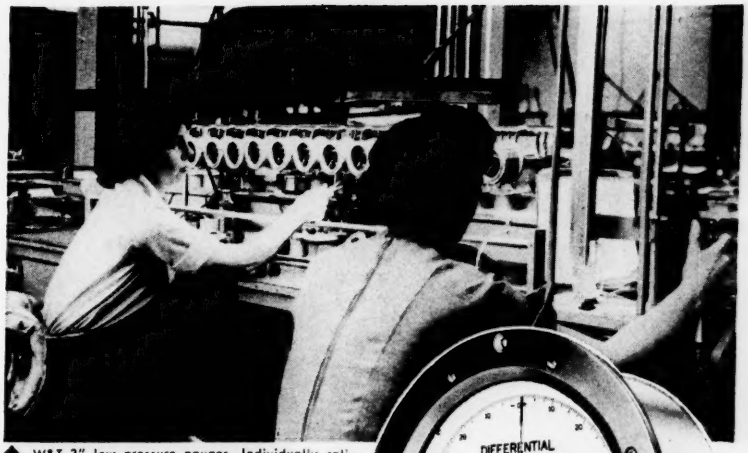
2039

platings on base materials, will detect surface and sub-surface cracks in smooth and rough coatings; is also designed for use in automatic process control. Range 0.00005" to 0.007"; accuracy 10%.—*Gulton Industries, 212 Durham Ave., Metuchen, N. J.*

For more information circle **571** on inquiry card.

LEAK-DETECTION SYSTEM

New Radiflo System is said to be the only method of its kind which lends itself to non-destructive mass-production testing of miniature units at extremely low cost; allows tested and rejected units to be reclaimed. Procedure: large tank containing units to be tested is sealed and Radene III, a non-toxic radioactive gas, is introduced at a pressure greater than internal pressure of the sealed units. Time is allowed (generally several hours) to permit entrance of gas to interior of "leakers." Then radioactive atmosphere is removed and the parts are put through a cleaning operation to decontaminate their outer surfaces so that only the "leakers" will be radioactive when passed before radiation counter. A leak rate equivalent to one



▲ W&T 3" low pressure gauges, individually calibrated, are checked against a precision standard.

A 6" gauge for easy readout is also available. ▶

PRESSURE MEASUREMENTS WITH PRECISION

W&T low pressure gauges bring 0.3% accuracy, rugged portability to your job

Calibration checked and double-checked . . . so you know the gauge is right when you record a reading. And W&T pressure gauges stay accurate in spite of rough handling. You can use them right on the job—still have laboratory accuracy.

These gauges are in stock now. For information write Dept. A-122.00

service: gauge pressure; differential pressure; vacuum determinations; or as compound pressure-vacuum gauges with zero center; **accuracy:** 1 part in 300; **sensitivity:** 1 part in 500; **minimum range:** 0 to 10 inches H_2O; **maximum range:** 0 to 400 inches H_2O; intermediate ranges of pressure or vacuum in any pressure equivalent are also available.

WALLACE & TIERNAN INCORPORATED
25 MAIN STREET BELLEVILLE 9 NEW JERSEY

W&T MERCHEN SCALE FEEDERS & METERS

for Automatic Batch Control
Continuous Blending
Materials Accounting

Control the feeding of ingredients by weight to an accuracy of 1%.
Capacities range from 3 to 3000 lbs. per min.

WRITE FOR YOUR COPY OF OUR BULLETIN:
"The Best Weigh is the Merchen Way."

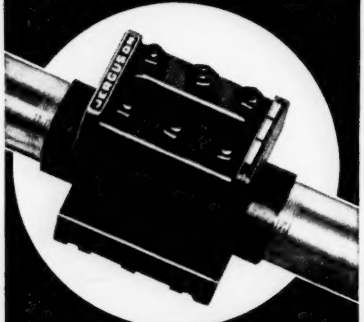
WALLACE & TIERNAN INCORPORATED
25 MAIN STREET, BELLEVILLE 9, NEW JERSEY

M-31

For more information circle **130** on inquiry card.

NEW . . .

Jerguson Sight Flow Indicators



easily and inexpensively installed to show movement of liquid in pipe lines

Here is a new line of Sight Flow Indicators . . . easily and inexpensively installed in any new or existing pipe line ½" to 2" N.P.T.

The special design of these new indicators results in a turbulence in the flow of liquid, making it easily visible. Several types of indicating vanes, installed within the chamber, may also be furnished, according to variable conditions of rate of flow and viscosity of liquid. For indication of minute flows, small Sight Flow Indicators with a rotating vertical rising ball are available.

Jerguson Sight Flow Indicators are soundly designed, carefully made, and are backed up by a company with over 40 years experience in the field. Available in Transparent and Reflex types, in a wide variety of materials and linings, and with Wedge Type Illuminators, Haveg Chambers, Non-Frosting Glasses or other special construction.

If you have a problem of viewing the flow of liquid in a pipe line, it will pay you to investigate the new Jerguson Sight Flow Indicators today. Send us your requirements or write for Data Unit.

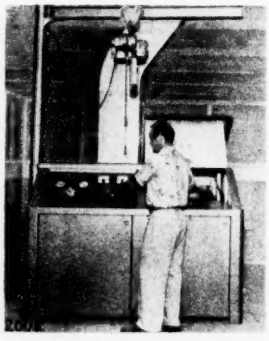
JERGUSON

Gages and Valves for the Observation of Liquids and Levels

JERGUSON GAGE & VALVE COMPANY
100 Adams Street, Burlington, Mass.
Offices in Major Cities
Jerguson Tress Gage & Valve Co., Ltd., London, Eng.
Pétrole Service, Paris, France

For more information circle **131** on inquiry card.

NEW INSTRUMENTS

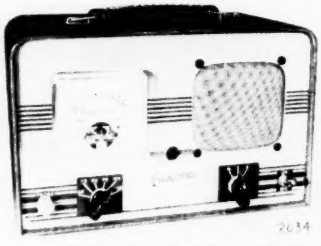


cubic inch or air at atmospheric pressure in five million years can be measured. Process allows wide latitude in leakage range specifications by altering (1) Radene III dilution, (2) pressure, (3) time exposure, (4) sensitivity of detector. Radioactivity from a "leaker" is generally not more than that from a radium-dial wrist watch. Personnel training must be approved by AEC.—*American Electronics, Inc., 655 W. Washington Blvd., Los Angeles 15, Calif.*

For more information circle **572** on inquiry card.

INDUSTRIAL STETHOSCOPE

New improved model of Electro-Probe for locating and analyzing vibrations and noise in mechanical de-

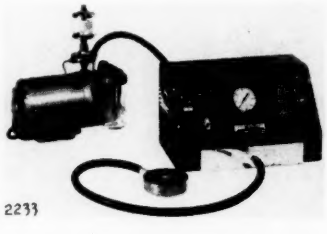


vices, and locating breaks and stoppage in piping system, is more sensitive; has increased power; incorporates a more stable electronic circuit. Pickup is equipped with an electromagnet in addition to rod probe in order to facilitate accurate vibration measurement.—*Erwood Inc., 1770 W. Berteau Ave., Chicago 13, Ill.*

For more information circle **573** on inquiry card.

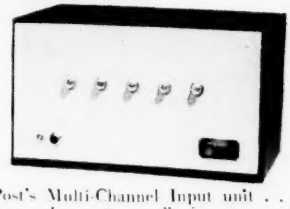
FLATNESS TESTER

New improved low-cost Flatness Tester permits unskilled labor to run tests with maximum efficiency;



Post Decitron electronic products

Model MC

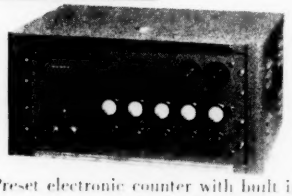


Post's Multi-Channel Input unit . . . accumulates "counts" from several different production lines where total count is desired, utilizes separate photoheads for each line. Anti-coincidence circuit keeps count accurate even if objects on two different lines break beam simultaneously.

Model SD-IT

Outmodes all mechanical counters. Capable of operating at speeds up to 100 units per second. Single "count" indicated on the six digit totalizer as each *tenth* item breaks the light beam. Counts dozens or gross with 12 place counting tube.

Model PW-5



Preset electronic counter with built in warning system. Available in models for counts of 1-100 (PW-2) to model with range 1-100,000 (PW-5). Will count in batches. Warning device may be used to coordinate secondary circuit just before desired count is reached. Will stop machine, cut, divert or perform any other operation. Automatically resets to zero when preset number is reached.

POST ELECTRONICS

Division of Post Machinery Co.
160 Elliott St., Beverly, Mass.

Decitron

POST ELECTRONICS
Division of Post Machinery Co.
160 Elliott St., Beverly, Mass.

☐ Send literature on Model _____
☐ Please send name of nearest representative

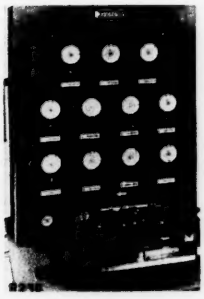
Name _____
Company _____
Address _____
City _____ State _____

For more information circle **132** on inquiry card.

comprises a vacuum pump, an instrument panel, and a testing plate which can be custom engineered in size, shape or material. In most cases, vacuum pull makes clamping fixtures unnecessary.—*Gits Bros. Mfg. Co., 1866 S. Kilbourn Ave., Chicago, Ill.*

For more information circle **574** on inquiry card.

MULTIPLE AIR GAGE



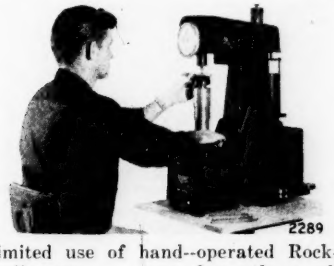
New Model EAS-1058 Modular Air-Electric Meter Switch greatly speeds measuring multiple dimensions by eliminating human error. Operator does not have to observe several bobbins or dials and decide whether or not every one falls into acceptable zone: he need observe only one large signal light which, when on, indicates that all dimensions are within tolerance. In addition, each unit has two lights for off-sizes: red for scrap, yellow for salvage. By glancing at a pointer, operator can see exactly how much off-size dimension deviates from tolerance.—*Federal Products Corp., 1144 Eddy St., Providence 1, R. I.*

For more information circle **575** on inquiry card.

mechanical testing

HARDNESS TESTER

New Rockwell Hardness Twin-Tester, for Rockwell and Rockwell Superficial applications requiring only



limited use of hand--operated Rockwell testers, can perform the work of two conventional single-range units.—*Wilson Mechanical Instrument Div., American Chain & Cable Co., Inc., Bridgeport 2, Conn.*

For more information circle **576** on inquiry card.

HIGH TEMPERATURE CEMENTS FOR STRAIN GAGES

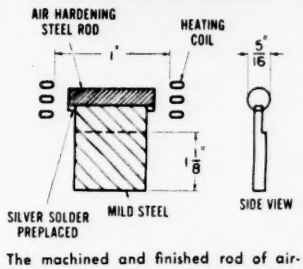
New Brimor high temperature cements, originally developed by Bristol Aero-Engines, Ltd., are main-

The Lepel Line of induction heating equipment represents the most advanced thought in the field of electronics as well as the most practical and efficient source of heat yet developed for industrial heating.

If you are interested in induction heating you are invited to send samples of the work with specifications. Our engineers will process and return the completed job with full data and recommendations without any cost or obligations.

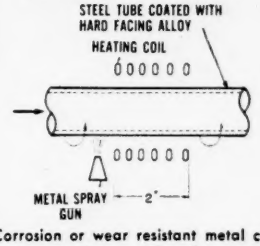
TYPICAL INDUCTION HEATING APPLICATIONS

SIMULTANEOUS HARDENING and BRAZING

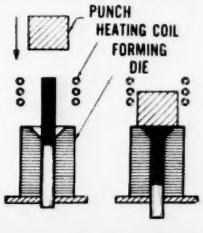


The machined and finished rod of air-hardening steel is simultaneously hardened and brazed to a mild-steel tab. Use of a purified hydrogen atmosphere and a high temperature brazing alloy permits successful hardening of alloy steels without discoloration and scaling even in the absence of flux.

DIFFUSION BONDING OF SPRAYED METAL COATINGS



Corrosion or wear resistant metal coatings sprayed on metal surfaces can be improved by heating to achieve alloying by diffusion. The drawing shows a typical arrangement for processing steel tube sprayed with hard facing alloy. Long tubes may be progressively sprayed and heated.



HEATING HIGH STRENGTH ALLOYS FOR FORMING

Uniform and rapid heating of high strength alloys (alloy steels, titanium, etc.) aids in upsetting and forming operations and also minimizes oxidation and embrittlement.

Electronic Tube Generators from 1 kw to 100 kw.
Spark Gap Converters from 2 kw to 30 kw.

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All Lepel equipment is certified to comply with the requirements of the Federal Communications Commission.

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55th STREET and 37th AVENUE, WOODSIDE 77, NEW YORK CITY, N. Y.

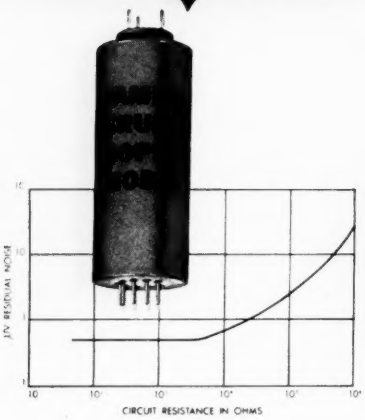
For more information circle **133** on inquiry card.

JAMES

10 μv

AT 400 CYCLES

LOW NOISE CHOPPERS



10 MICROVOLT D.C. INSTRUMENTATION NOW POSSIBLE WITH JAMES 400 CPS CHOPPERS

- Double pole double throw switching for dual input or input/output circuits.
- New miniature packages.
- Both make before break and break before make closures.
- Models for driving frequencies of 5 to 450 Cps.
- Low driving power—less than .2 watts at 400 Cps.
- Operations unaffected by shock, temperature and vibrations.

JAMES is the complete source of critical components for low level D.C. amplifications, supplying choppers, transformers and chopper drivers.

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For more information circle **134** on inquiry card.

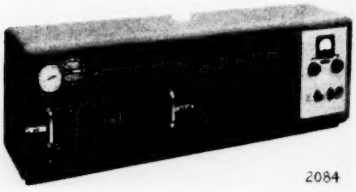
NEW INSTRUMENTS

ly used for securing wire and foil strain gages to components prior to high-temperature tests. Two Brimor compositions are available in 1-lb containers: (1) Brimor U527 medium hardness cement used where strains are large and are associated with high-frequency vibration; (2) Brimor U529 has a higher bond strength producing a hard and tenacious cement when finally cured; used when a high degree of cement/metal adhesion is required, as where gages are attached to gas turbine rotor components.—*Morganite Inc., 3302-48th Ave., Long Island City 1, N. Y.*

For more information circle **577** on inquiry card.

ENVIRONMENT TEST CHAMBERS

New Model TC-5 48x16x12" Temperature Test Chamber has a control accuracy of 0.5 C° between

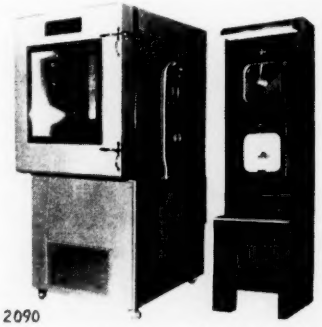

2084

−70°C and 200°C; interchangeable test trays for production-line testing. Fast warm-up permits stabilization of temperature at 150°C within 10 min after changing trays. Temperature gradient across tray will not exceed 1 C° from the set point.—*Statham Development Corp., 12411 W. Olympic Blvd., Los Angeles 64, Calif.*

For more information circle **578** on inquiry card.

ENVIRONMENT TEST CHAMBERS

New Series 30 temperature test chambers with 30 cu ft of workspace feature low temperature ranges of


2090

−40°F, −100°F, −120°F, high temperature ranges of 240°F or 350°F and (optional) relative humidities of 20% to 98% (limited by 35°F dewpoint) and 5% at 160°F.—*Tenney Engineering, Inc., 1090 Springfield Rd., Union, N. J.*

For more information circle **579** on inquiry card.

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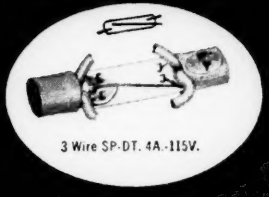
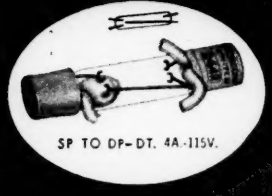
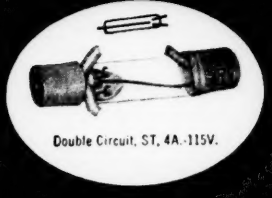
HERMETICALLY SEALED MERCURY SWITCHES

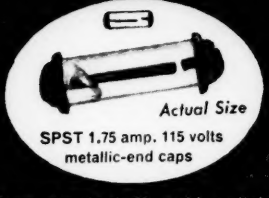
TILTING TYPE AVAILABLE CIRCUITS


3 Wire SP-DT. 4A.-115V.


SP TO DP-DT. 4A.-115V.


Double Circuit, ST, 4A.-115V.

SP-ST. 10A 115V.
SP-ST. 25A.-115V.


Actual Size
SPST 1.75 amp. 115 volts metallic-end caps

Many standard Mercoid switches are available write for Bulletin –54

THE MERCOID CORPORATION
4201 BELMONT AVE., CHICAGO 41, ILL.

For more information circle **135** on inquiry card.

HYDROSTATIC TESTER

New lightweight HydroKit weighs 17 lb; comprises a 3,000-psi hand-operated pump, precision pressure gage

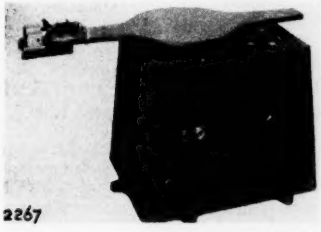
2229

(0-500 psi standard, others available) and easy-to-fill reservoir base.—*Farris Engineering Corp., 400 Commercial Ave., Palisades Park, N. J.*

For more information circle **580** on inquiry card.

ANGULAR ACCELERATOR

New Angular Acceleration Generator, capable of generating closely-controlled angular and near-linear



2267

acceleration motion, imparts sinoidal angular motion to a test table. It does not deliver rotary motion around a fixed axis: all points not on axis move in circles concentric with axis and in planes perpendicular to it. Hence, angular acceleration over a wide frequency range can be generated within compact limits.—*Statham Development Corp., 12411 W. Olympic Blvd., Los Angeles 64, Calif.*

For more information circle **581** on inquiry card.

GEAR-TRAIN ANALYZER

New Gear Train Analyzer evaluates lost motion in precision gear trains; comprises an electronic con-

2023

trol console to which is connected a two-phase torque actuator bearing a read-out dial which indicates angular

NEW... ALL THE WAY THROUGH

Hickok, manufacturer of the world's most accurate laboratory tube tester, announces the expansion of their Research and Development type test equipment line. Three of the newest models are listed here.

MODEL 1600

New, High Frequency VACUUM TUBE VOLTMETER

20 cycles to 700 megacycles • Low Input Capacity • High Input Impedance • Voltage Regulated • Stable

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MODEL 1715

New, SQUARE WAVE GENERATOR

Frequency range of 1 cycle to 1 megacycle
Rise time of 0.02 microseconds
• New Centerline Construction • Stable
• Wide Frequency Range • Voltage Regulated

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MODEL 1810

New, 5" OSCILLOSCOPE

4 megacycle band width vertical amplifier 10 millivolt peak-to-peak per cm sensitivity
• AC or DC Vertical Amplifier Inputs Controlled by Selector Switch • Triggered or Recurrent Sweeps—Variable From 2 to 30,000 Cycles
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RD INSTRUMENTS

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For more information circle **136** on inquiry card.

Designed and Manufactured by E. H. SARGENT & CO.

THE SARGENT LABORATORY RECORDER

Patents Pending

An automatic, self-balancing potentiometric recorder which measures voltages or current and graphically records these variables as a function of time.

- **MULTI-RANGE**—40 ranges.
- **MULTI-SPEED**—9 standard chart speeds.
- **VOLTAGE OR CURRENT RECORDING** for measurement of voltage or current or any other variable which can be translated to voltage or current signals.
- **FLEXIBILITY OF APPLICATION**
- **DESIGNED FOR BENCH OPERATION**

Style: Vertical strip chart recorder, designed for laboratory bench operation. Assembly of three individual, separable, and self contained units: viz., control panel assembly, amplifier and power supply chassis, and chart and pen drive chassis unit.

Automatic null balancing potentiometric system with standard cell standardization by panel control, conventional chopper-amplifier method with special Sargent high gain amplifier and high stability Sargent bridge power supply using combined or alternate dry cells and mercury cells. Use of the latter obviates need for standardization over very long periods.

Ranges: Multiple full scale ranges selected by panel range switch as follows: 1.25, 2.5, 5, 12.5, 25, 50, 125, 250, 500, 1250, 2500. All ranges are made direct reading as full scale deflection in millivolts, milliamperes, or microamperes by use of an associated units selector switch. All 33 scales provide true potentiometric measurement. An additional series of the same eleven ranges in terms of volts is provided by an additional selector switch position, this series using a divider input with an impedance of one megohm.

True potentiometric measurements are thus provided to a maximum of 2.5 volts, higher voltages only being measured through a divider.

Accuracy: 0.1% or 20 microvolts, whichever is greater.

Chart: Width, 250 mm; length, 120 feet. Ruling rational with all ranges on a decimal basis. Indexed for reference. Graduated steel scale provides for any necessary correction of calibration. Two-position writing plate, 15° or 40° from vertical.

Chart Drive: Forward drive recording, reverse drive recording, magnetic brake eliminating coasting when stopped and free clutch position with separate provision for rapid non-synchronous drive.

Recording speeds of ⅓, ½, 1, 1½, 2, 2⅔, 4, 8, and 12 inches per minute, selected by interchange of two gears on end of chassis.

Free clutch or neutral drive at the rate of approximately 20 feet per minute in either direction for rapid scanning of recorded information, chart reroll, or chart positioning.

Recording either by automatic take-up on roll or with free end chart and tear off.

Synchronous switching outlet for automatic synchronization of external devices with recording.

Pen Speed: 1.8 seconds full scale. Other speeds can be provided on special order with change of motors.

Bridge: Special Sargent specification, ganged Helipot with resolution several times common commercial practice. Provision for coupled transmitting potentiometer for output to integrating circuits, etc.

Damping: Dynamics controlled with single panel knob adjustment of amplifier gain.

Dimensions: Width, 21½ inches; depth, 13 inches; height, 24 inches; weight, about 75 pounds.

S-72150 RECORDER—Potentiometric, Sargent. Complete with two S-72165 chart rolls; two each S-72175 pens; red, blue and green; input cable assembly; synchronous switch cable assembly; plastic dust cover; spare ring for take-up mechanism; spare pen drive cable assembly; and fuses. For operation from 115 volt, AC., single phase, 60 cycle circuits..... **$1725.00**

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For more information circle **137** on inquiry card.

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For more information circle **138** on inquiry card.

NEW INSTRUMENTS

displacement of actuator shaft during test; also measures torque required to drive free running gear boxes, facilitates adjustment of gear meshes and bearing alignments during assembly.—*Daco Instrument Co., Tillary & Prince Sts., Brooklyn 1, N. Y.*

For more information circle **582** on inquiry card.

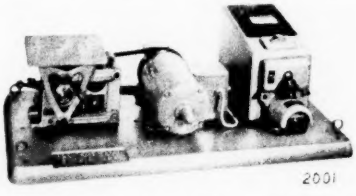
COMPRESSION SOIL TESTER

New portable hand-driven machine performs unconfined compression tests on soils and provides a permanent record of all tests performed. Kit includes four calibrated springs, extruder for sample preparation, tripod, flat platens, and transparent celluloid calibrated mask for interpreting chart records.—*Soiltest Inc., 4711 W. North Ave., Chicago 39, Ill.*

For more information circle **583** on inquiry card.

VIBRATION-FATIGUE TESTER

New vibration fatigue testing machine for pretesting parts and assemblies weighing up to 10 lb pro-



vides harmonic-motion vibrations steplessly variable from 5 to 100 cps. Range selector provides automatic acceleration and deceleration within any given span of total cps range; for example, from 5 to 55 cps and back to 5 repeatedly, or 41 to 91 and back; or held at one frequency.—*All American Tool & Mfg. Co., 8017 Lawndale Ave., Skokie, Ill.*

For more information circle **584** on inquiry card.

electrical testing

AUTOMATIC ELECTRIC TESTER

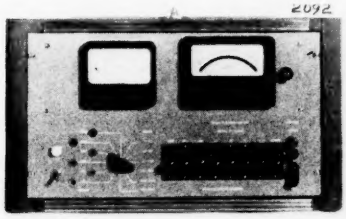
New Tape-Programmed Supertester places production and maintenance testing on a push-button basis; makes circuit, voltage, and operational tests according to specs dictated by a punched paper tape; can perform all functions of an average-sized test de-

partment. At completion of testing, a list of the faulty circuits and components is presented to accompany defective unit to repair department.—*California Technical Industries Div., Textron Inc., Belmont, Calif.*

For more information circle **585** on inquiry card.

DIODE & TRANSISTOR TESTER

New Model BT 5001A, for quantity testing as well as for lab, measures saturation currents of diodes and

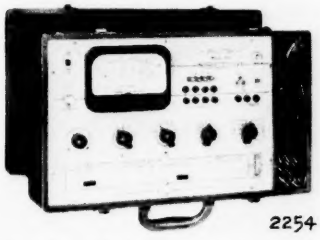


transistors; has six voltage ranges from 0-10 to 500-700 and fourteen current ranges from 10^{-9} to 10^{-3} amp full scale. Unique circuitry allows zero control to balance out any leakage current in mounting jigs, cables, etc.—*Trans Electronics, Inc.*, 7349 *Canoga Ave., Canoga Park, Calif.*

For more information circle **586** on inquiry card.

TRANSISTOR TESTER

New Model 960 portable transistor and crystal diode tester is said to be the only semiconductor tester in its

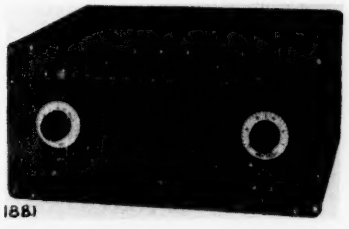


price class that gives comprehensive tests for I_{CBO}, gain, leakage, shorts, etc., on low, medium and high-power transistors of both *p-n-p* and *n-p-n* types, as well as the new tetrode transistors.—*Precision Apparatus Co., Inc., Glendale, L. I., N. Y.*

For more information circle **587** on inquiry card.

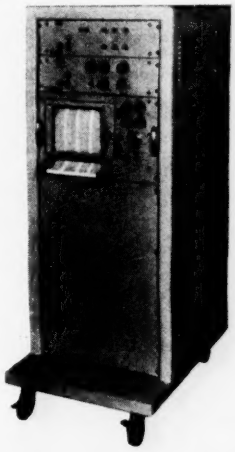
TEST OSCILLATOR

New Model TO-258 Telemetering Test Oscillator features push-button selection of standard FM/FM fre-

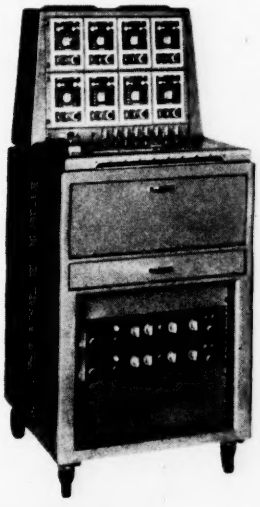


What do you need in oscillograph recorders ?

EDIN Recording Instruments accurately depict, measure and permanently record phenomena, instantly. EDIN products handle the entire measurement problem from start to finish . . . from the transducer through the recording instrument and accessories to the chart paper. Flat frequency response from DC to 200 cps. The complete line of EDIN instrumentation is available with ink, electric or heated-stylus write-out.



Edin Rack-Panel Oscillographs —Feature rack-panel mounted recorders with true rectilinear recording, pop-out paper loading, 8-speed electric gear shifting, optional remote control. Wide choice of rack-panel cabinets available. EDIN Rack-Panel amplifiers are suitable for measuring hundreds of different phenomena.



Edin Modular Oscillographs —Expandable, versatile, interchangeable. Start with as few as 2 channels. Then, add up to 6 more channels. Plug-in preamps are added in seconds for measuring almost any phenomena.

Edin Chart Papers —Produced in standard roll forms and in the exclusive "Z"-folded form which stacks itself. "Z" pages are numbered and are easily fanned for reviewing.

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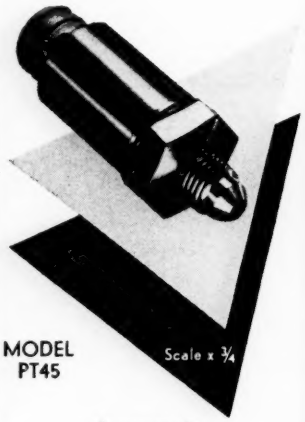
For more information circle **139** on inquiry card.

Dynisco

PRESSURE PICKUP



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For more information circle **140** on inquiry card.

NEW INSTRUMENTS

quencies from 400 cps to 70 kc with calibrated deviation control of ±15% of center frequency. Special models can be supplied with frequencies from 20 cps to 100 kc.—*Teletronics Laboratory Inc., 54 Kinkel St., Westbury, L. I., N. Y.*

For more information circle **588** on inquiry card.

AUTOMATIC GO NO-GO SEQUENCE TESTER

New Autotest programs and performs any number of pre-operational GO, NO-GO tests and then initiates

operation only upon successful completion of test sequence. Any NO-GO indication halts test sequence at offending channel.—*Optimized Devices, Inc., Box 38, Gedney Station, White Plains, N. Y.*

For more information circle **589** on inquiry card.

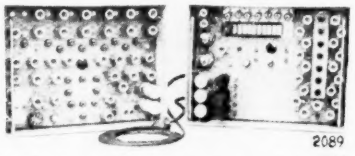
FREQUENCY MARKER

New Marker Frequency Generator is said to be "the first simple yet absolutely precise instrument" for determining received signal frequencies, for calibrating receivers and transmitters, and for use as the oscillator in microwave transmitters for frequency control. It provides eleven simultaneous marker signals between 2,000 and 4,000 Mc at increments of 200 Mc. (It can be made for lower or higher frequency ranges, and frequency increments between markers can be greater or less.)—*Allen B. Du Mont Labs, Inc., 750 Bloomfield Ave., Clifton, N. J.*

For more information circle **590** on inquiry card.

TV TEST SIGNAL KEYER

New Model 1008-A Vertical Interval Keyer features new method of inserting standard test signals in



black line between frames of a TV picture (vertical blanking interval), allowing broadcasters to transmit test and picture-level reference signals during program time so that all facilities can be properly adjusted while programs are in progress.—*Telechrome Mfg. Corp., 28 Ranick Drive, Amityville, L. I., N. Y.*

For more information circle **591** on inquiry card.

HOW

precious metal metallurgy works for you!

The J. M. Ney Company, with more than 146 years in the highly specialized precious metal business, has gathered a wide background of information for analyzing the properties and uses of precious metal alloys and developing alloys for specific applications.

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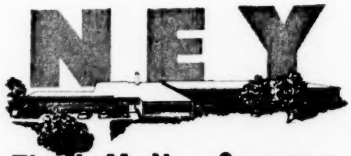


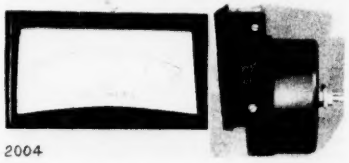
The J. M. Ney Company
P.O. Box 990, Dept. E, Hartford 1, Conn.

For more information circle **141** on inquiry card.

electrical and electronic instruments

INDICATING INSTRUMENTS

New Model 561 features better visibility of instrument itself and improved appearance of equipment in



2004

which it is used; reduces magnetic mounting panel error because its magnet pole-pieces are in back of panel, not in the same plane with it.—*Assembly Products, Inc., Chesterland, Ohio.*

For more information circle **592** on inquiry card.

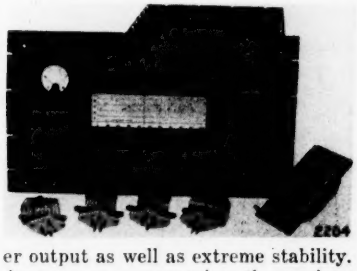
CREST VOLTMETER

New precision 0-1-kv electrostatic voltmeter with multipliers measures positive peaks, negative peaks or true rms values solely by means of switching. Choice of pulse response from 10 to 99 or 100 and above, also by switch. Operation: pulsating dc or ac. Normally made for bench use; available for panel mounting.—*Sensitive Research Instrument Corp., New Rochelle, N.Y.*

For more information circle **593** on inquiry card.

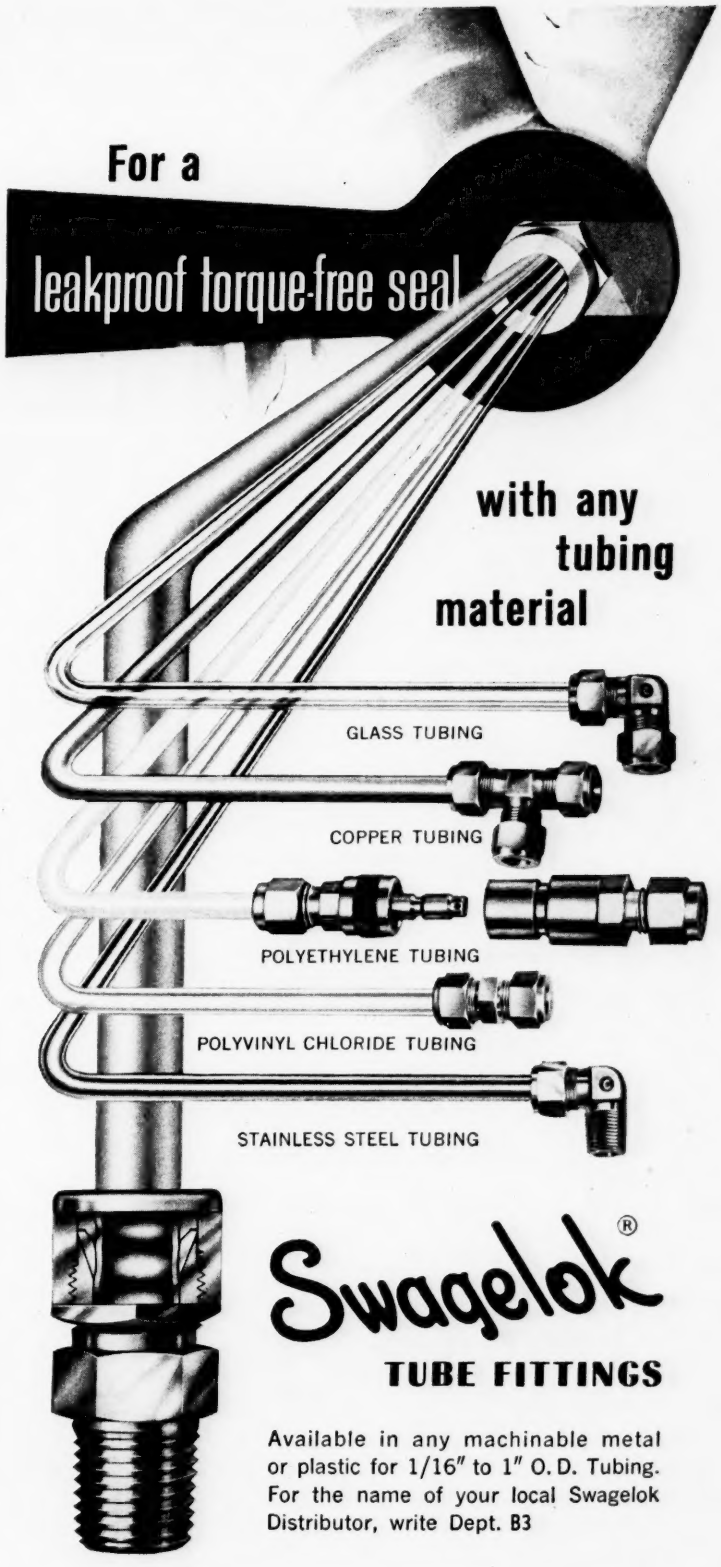
PULSED OSCILLATOR

New PG-650 Oscillator variable-frequency pulse-modulated RF source is for applications requiring high pow-



2204

er output as well as extreme stability. Among uses: measuring the various parameters of ultrasonic delay lines whose high initial insertion loss as well as operation at low impedance levels previously presented many dif-



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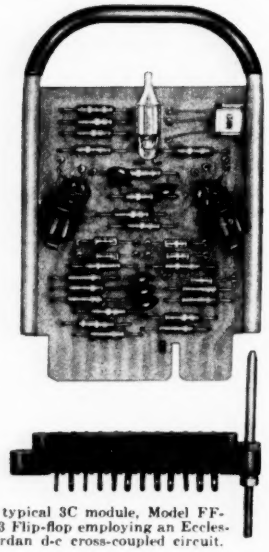

A typical 3C module, Model FF-103 Flip-flop employing an Eccles-Jordan d-c cross-coupled circuit.

The M-PAC family includes flip-flops, pulse amplifiers, gates, buffers, emitter-followers, variable frequency oscillators, crystal-controlled oscillators, inverter amplifiers, one-shot multivibrators, and others.

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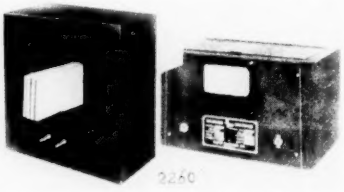
NEW INSTRUMENTS

ficulties. Not only can RF output be displayed directly on a CRO but a delay line output (60 db into 50 ohms) can also be shown at 4% using only vertical amplifier of CRO. It is possible also to cascade two delay lines without an intermediate amplifier.—*Arenberg Ultrasonic Laboratory, Inc., 94 Green St., Jamaica Plain 30, Mass.*

For more information circle **594** on inquiry card.

DC CURRENT TRANSDUCER

New D.C. Current Transducer measures high direct currents; comprises an ac window-type current trans-



former through which dc bus bar or cable is passed. Two saturable core reactors magnetically coupled to dc bus produce and ac signal linearly proportional to dc in bus bar; separate excitation voltage is applied to secondary by isolation transformer. Ac secondary is rectified and indicated.—*Rapid Electric Co., 2881 Middletown Rd., New York 61, N. Y.*

For more information circle **595** on inquiry card.

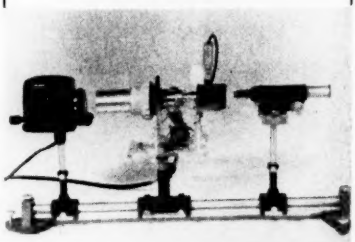
VOLTAGE-DIGITAL CONVERTER

New Voldicon operates either as a digital voltmeter or as an analog-to-digital converter; is capable of 2,000

completely independent conversions per second; is fully transistorized. Signal accompanied by noise can be read without confusion: true signal shows brightly, noise can be estimated by dimly-lit other numbers. Voldicon can be incorporated into practically any system because of variety of outputs: (1) visual output, (2) true decimal output for driving typewriters or punches directly, (3) binary-coded decimal output, (4) arbitrarily coded decimal output at slight additional cost. Encoding is accomplished by a matrix which operates from true decimal output. Voldicon allows user to choose his own codes simply by pulling slides on which matrix is mounted and changing jumpers. —*Adage, Inc., 292 Main St., Cambridge, Mass.*

For more information circle **596** on inquiry card.

A NEW APPROACH TO THE PROBLEMS OF INSTRUMENTATION



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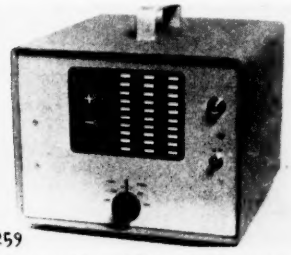
DIGITAL VOLTMETER

New DVM-1 transistorized digital voltmeter can be set for full-scale readings of plus 10, 100 or 1000 v or



2259

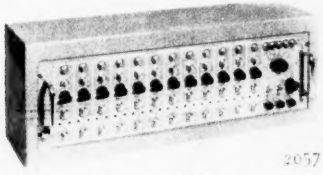
minus 10, 100 or 1000 v and measures voltages to a full-scale accuracy of better than 0.5%. Unknown voltage is measured by comparing it with a known voltage which increases in steps of 0.001 of full-scale reading at the rate of 1500 per second. New readings appearing at 2-sec intervals. —*Ransom Research, 323 W. 7th St., San Pedro, Calif.*

For more information circle **597** on inquiry card.

electrical-instrument accessories

BRIDGE BALANCE UNIT

New Model 438-B serves between a one-, two-, or four-arm type strain-gage pickup and an oscillograph; has



2057

provisions for completing any part of bridge circuit not contained in pickup and for balancing bridge and adjusting sensitivity. Automatic standardization can be accomplished either by series or parallel methods. —*Magnecord Div., Midwestern Instruments, Tulsa, Okla.*

For more information circle **598** on inquiry card.

CURRENT LIMITER

New Form 101 Amp Trap protects delicate electronic circuitry; becomes current limiting at about four times

2217

its normal current rating. It anticipates and prevents the rise of fault

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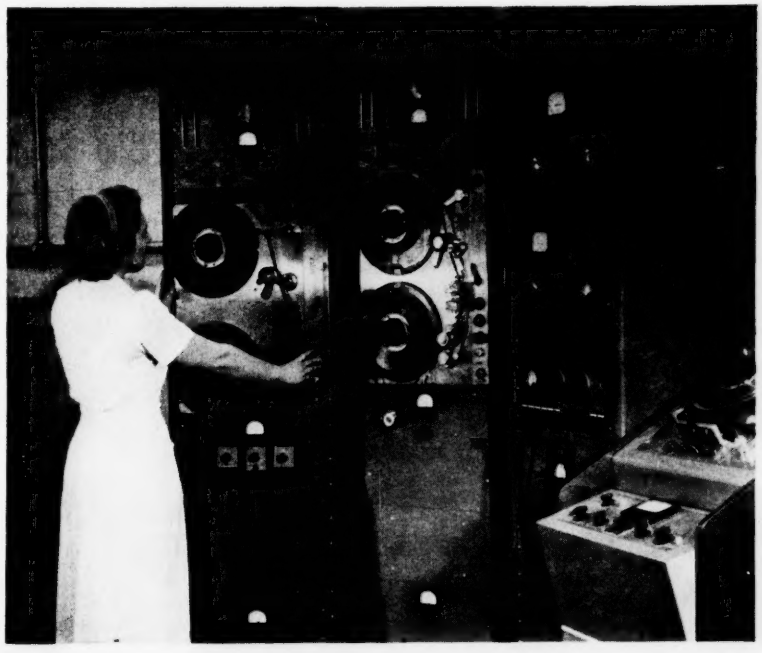

The machine above is a unique testing instrument, designed by Audio Devices engineers and installed at the Audiotape plant in Glenbrook, Conn. This Automatic Defect Counter records and plays back every inch of the EP Audiotape under test.

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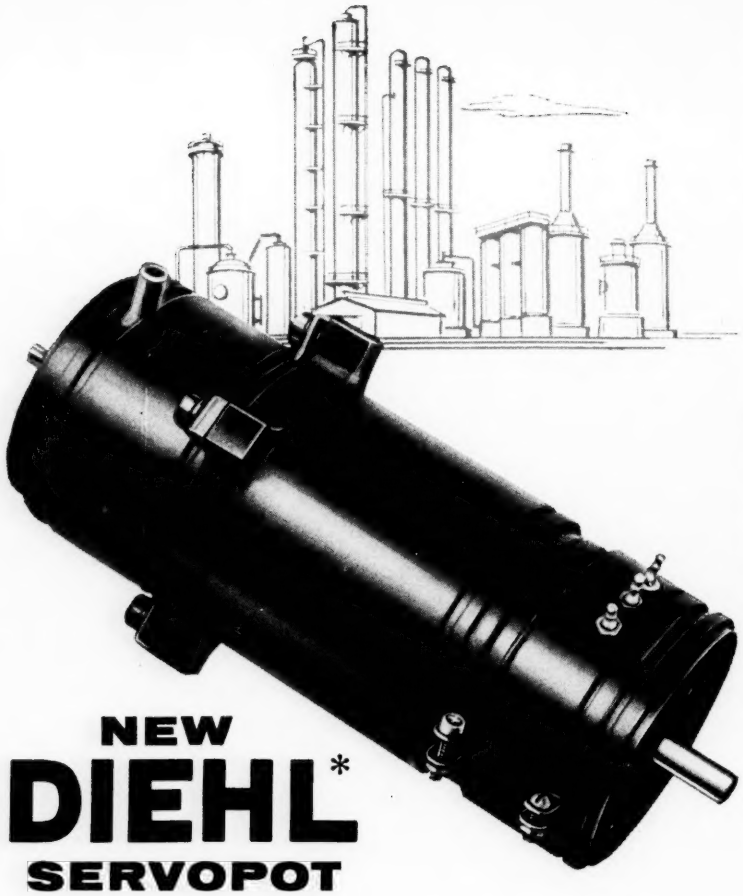

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currents to high destructive maximums. "No other circuit protective device is fast enough to do this." It will continuously carry from 1 to 10,000 amp of normal current. Depending on its rating it limits on overload and blows instantly on short circuit before damage can be done.—*The Chase-Shawmut Co., Merrimac St., Newburyport, Mass.*

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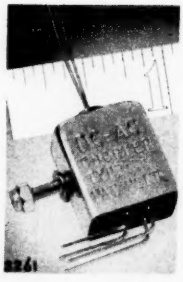
DC-AC CHOPPER



New dc-ac chopper features micro-miniaturization without sacrificing contact rating, ruggedness, reliability, or long life; weighs less than ¼ oz with hardware; is designed for military applications; has temperature range of −65°C to 125°C; hermetic seal driving range 0 to 1800 cps. Three series: R-20 with null switching configuration; R-70 with n-o or n-c switching; R-80 with snap-action switching.—*Rawco Instruments Inc., 3527 W. Rosedale, Fort Worth 7, Tex.*

For more information circle **600** on inquiry card.

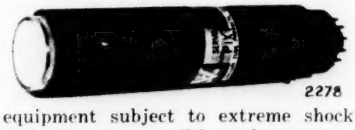
DC AMPLIFIER

New Model 1350 facilitates multichannel (commutated) analog-digital conversion of strain-gage signals. Adjustable passband control can be set to suit sampling rate; output limiting circuit prevents a broken gage or other malfunction on one channel from saturating the rest of the commutation system. Other features include signal compression, extra low noise, voltage gains up to 1000, 2-microvolt zero stability, and 100-kilohm input impedance.—*Dynamics Instrumentation Co., 1118 Mission St., South Pasadena, Calif.*

For more information circle **601** on inquiry card.

CATHODE-RAY TUBE

New ruggedized Model VTP-P-1XP-11, 7½" long, designed for mounting directly to airframe and for use with



2278

equipment subject to extreme shock and vibration conditions, has a useful screen of 1" minimum and Mumetal shield; is a post-acceleration type tube that provides high-quality presentation.—*Vacuum Tube Products Co., 2020 Short St., Oceanside, Calif.*

For more information circle **602** on inquiry card.

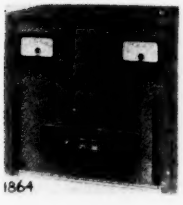
DIFFERENTIAL DC AMPLIFIER

New 114A features input and output both floating and completely isolated from each other; unique chopper-stabilized circuitry whence extremely high common-mode rejection, low drift, high output capability, and excellent stability and linearity—all unaffected by load or gain changes. Ideal for thermocouple amplification, etc.—*Kin Tel Div., Cohu Electronics, Inc., 5725 Kearny Villa Rd., San Diego 11, Calif.*

For more information circle **603** on inquiry card.

power supplies

MEDIUM-VOLTAGE SUPPLY



New RS 40 B, germanium rectifier type, has a continuously-adjustable output of 0 to 110 vdc with 20-amp max load rating. Ripple does not exceed 1%; regulation is 5-6% from 1/10 load to full load at 110-v output.—*Opad Electric Co., 69 Murray St., New York 7, N. Y.*

For more information circle **604** on inquiry card.

AC POWER SUPPLY

New 2-kva single-phase model of Invertron is available in models with various output frequencies, both variable and fixed. Model shown has 50-1350-cps output frequency range, 0-130 output voltage, single phase, 2 kva. Input is 230 v, 60 cps, single phase.—*Behlman Engineering Co., 2911 Winona Ave., Burbank, Calif.*

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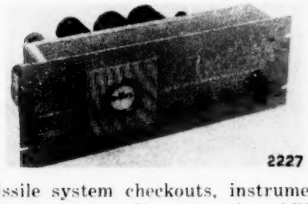

missile system checkouts, instrument calibration, etc. Exceptional stability is derived from an exclusive high-Q

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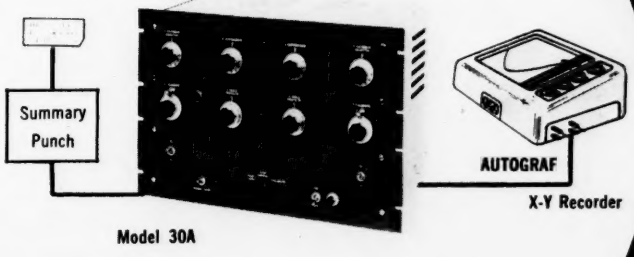

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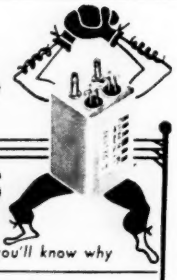

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For more information circle **152** on inquiry card.

NEW INSTRUMENTS

LC-tuned circuit and special voltage-sensitive bridge. Available in rack (illus.) or cabinet models.—*Electronics International Co., 145 W. Magnolia Blvd., Burbank, Calif.*

For more information circle **606** on inquiry card.

LV DC SUPPLIES

Six new all-transistor low-voltage high-current dc supplies (first of new Q Nobatron line) offer performance

1875

on a par with that of B-type high-voltage dc supplies; feature low ripple, fast response, transient-free performance, adjustable output, wide input-frequency range, complete self-protection, isolated output, and low cost.—*Sorensen & Co., Inc., South Norwalk, Conn.*

For more information circle **607** on inquiry card.

REGULATED POWER SUPPLIES

New low-voltage high-current transistorized regulated dc power supplies deliver from 10 to 30 vdc, adjustable and regulated to better than 0.1 v for load changes of 0 to 10 amp and for input line variations of 110 to 120 vac. There is no transient at output when switching from power-off to power-on. Response time 5 ms for recovery from no-load to full-load or full-load to no-load. Transient wave is damped and does not oscillate. Ripple is held to 3 mv peak-to-peak at rated load. Dimensions 19" W x 7½" H x 10" D. Delivery from stock.—*Modern Industries, Inc., 2601 Colorado Ave., Santa Monica, Calif.*

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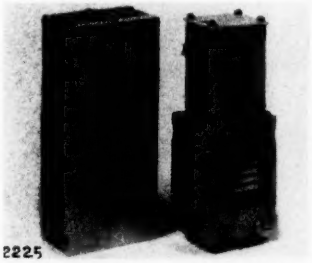
REGULATED POWER SUPPLIES

New transistor regulated power supplies, for strain-gage bridges, etc., requiring low-noise ungrounded sup-



2225

plies, are available in nine different models for 117-v 60-cps input; output voltages from 10 to 50.—*Elcor Inc., P. O. Box 354, McLean, Va.*

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electrical components

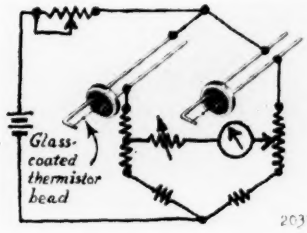
COAXIAL CAPACITORS

New capacitors are made by unique process of combining porcelain dielectrics and fine silver electrodes in a monolithic block. A terminal at center of this 0.45" square capacitor permits currents to flow radially through the electrodes and dielectrics to the four terminals at periphery. Geometry results in cancellation of magnetic fields of these radial currents, whence low effective inductance of capacitor. Extremely stable temperature coefficient of 115±25 ppm/C° through entire ambient range of −55°C to 125°C. Q >2500 for all capacitance values. Rugged design can take 20-G vibration up to 2000 cps.—*Vitramon, Inc., Box* 544, *Bridgeport* 1, *Conn.*

For more information circle **610** on inquiry card.

MATCHED THERMISTORS

New voltage-current matched thermistor assemblies, particularly useful in gas analysis, are available



as regular production items, with complete specs including time constants, dissipation constants in air and helium, power ratings, maximum continuous temperatures, and resistances at various temperatures.—*Fenwal Electronics, Inc., Mellon St., Framingham, Mass.*

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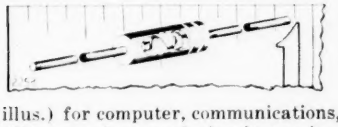
electronic components

SILICON DIODES

New line of subminiature silicon junction diodes is headed by uniquely-versatile inventory-reducing 1N658



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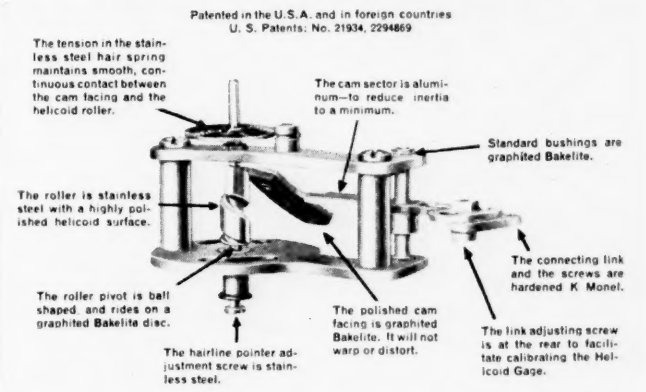
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The link adjusting screw is at the rear to facilitate calibrating the Helicoid Gage.
The hairline pointer adjustment screw is stainless steel.

The superiority of Helicoid Gages is most evident in severe service—wherever a gage is subjected to violent pressure pulsations or severe mechanical vibrations.

The *sustained accuracy* of Helicoid Gages over *millions of cycles* is explained by the details of design and construction of the Helicoid movement shown above. Such Helicoid features—protect against wear and corrosion and assure sensitivity, sustained accuracy and trouble-free operation.

The Chemical Gage

The Helicoid Chemical Gage has a guaranteed accuracy of plus or minus 1%. It is applicable for working pressures from 30" vacuum to 5000 p.s.i. and temperatures to 400° F. It is particularly suitable for chemicals and other viscous fluids which might clog or corrode a Bourdon tube. Pressure and/or vacuum is transmitted directly to the indicating gage element through deflection of a Teflon or Kel F sealing diaphragm.

Tubes built for millions of pressure pulsations

To fit the wide range of applications, Helicoid Bourdon tubes are available in four materials—alloy steel, K Monel, stainless steel and phosphor bronze.

All Helicoid tubes are made from seamless tubing and are carefully designed to give maximum torque and minimum stress. When used within the dial range, they will withstand many millions of pressure pulsations and will not stretch, leak or crack.

For complete information on the Helicoid line of gages write for **Catalog G-52**

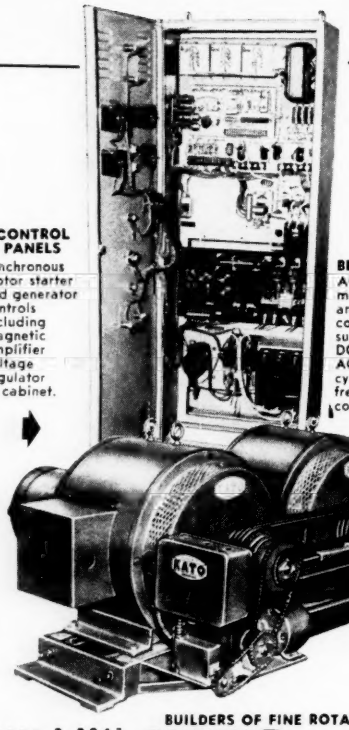
Helicoid gives you all these features at prices that are competitive in the quality gage field.

Helicoid Gage Division
AMERICAN CHAIN & CABLE

929-B Connecticut Avenue • Bridgeport 2, Connecticut

ACCO
TRADE MARK

For more information circle **153** on inquiry card.



KATO

VARIABLE FREQUENCY MOTOR GENERATOR SETS

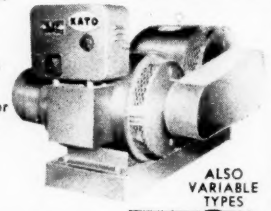
FOR BETTER BENCH MOCK UP TESTS

Adjust 360 to 440 cps. Generator mounted controls include reset buttons, limit switch. Motor and Generator remain stationary. Variable drive pulley adjustment is controlled by small motor.

CONTROL PANELS
Synchronous motor starter and generator controls including magnetic amplifier voltage regulator in cabinet.

ALSO 60 CYCLE AC GENERATORS FROM 350 WATTS TO 500 KVA!

BELTED TYPES
Available in many input and output combinations such as AC to DC, DC to AC, 50 to 60 cycle and other frequency combinations.



ALSO VARIABLE TYPES

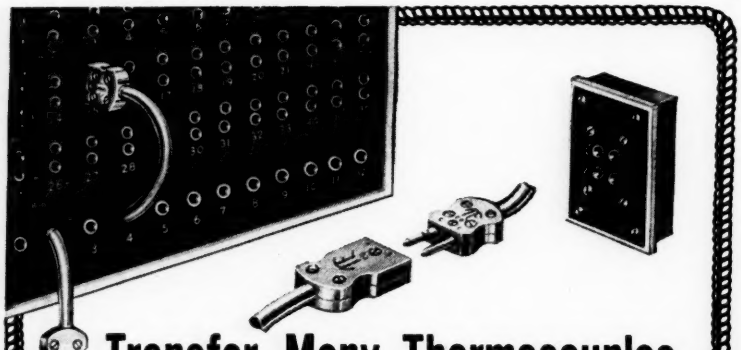
REMOTE CONTROL PANELS
Remote control Frequency adjustment varies speed from 1080 to 1320 rpm thus varying frequency Bench mock-up test station may be located anywhere.

BUILDERS OF FINE ROTATING ELECTRICAL MACHINERY SINCE 1928

Phone 8-2941 OR WRITE TODAY FOR FOLDER!

KATO *Engineering Company* 1490 FIRST AVENUE MANKATO, MINNESOTA

For more information circle **154** on inquiry card.



Transfer Many Thermocouples

With T-E Quick-Coupling Connectors and Panels

Connector Panels T-E has one for your exact needs. These panels provide flexible, centralized control in transferring any number of thermocouples to indicating, multipoint recording and controlling pyrometers. Ideal for patch panel use, they are available in many compact shapes and sizes — with interchangeable plugs and jacks in I-C, C-C, and C-A. A panel for 48 thermocouples and 16 pyrometers measures only 13¼" x 7⅞". Polarity markings and screw-fastened connections make wiring easy.

Quick-Coupling Connectors These connectors permit fast, easy making and breaking of thermocouple circuits. Durable construction guarantees long, dependable usage. Polarized and mechanically interchangeable, all plugs and jacks are of standard matched thermocouple materials. Spring-loaded contacts with long wiping surfaces provide firm but easily broken connections.

Write for Bulletin 23 F

Thermo Electric Co. Inc.
SADDLE BROOK, NEW JERSEY
In Canada—THERMO ELECTRIC (Canada) Ltd., Brampton, Ont.

For more information circle **155** on inquiry card.

ance and fast (0.3 usec) recovery, high peak inverse voltage (120), low reverse leakage of 0.05 ua at −50 v and 25°C and 25 ua at −50 v and 150°C; operating temperatures −65°C to 175°C; will handle average rectified current of 200 ma and has a power dissipation rating of 200 mw. —*Radio Receptor Co., Inc., 240 Wythe Ave., Brooklyn 11, N. Y.*

For more information circle **612** on inquiry card.

SILICON VOLTAGE REGULATOR & REFERENCE ZENER DIODES

New complete line of 64 silicon Zener voltage-regulator and reference diodes includes miniature types rated at 500 mw; standard top-hat style with pigtail leads rated at 1 w; 3.5-w and 10-w types featuring stud construction; 350-mw double anode types; 5-w multiple-junction high-voltage types and IN430, IN430A and IN430B reference element types. All meet rigid MIL specs, operate between −65°C and 150°C with high load current capacity owing to advanced thermal design. Sharp reverse breakdown characteristics provide the means for obtaining stable voltage regulation over a wide operating range. An *X-Y* plot of reverse breakdown characteristics is supplied with each diode.—*International Rectifier Corp., 1521 E. Grand Ave., El Segundo, Calif.*

For more information circle **613** on inquiry card.

COLD-CATHODE DIODE TUBE

New miniature gas-trigger TAA-113 is said to be ideal for electronic, avionic and missile applications. Nominal firing voltage 113 v; leakage resistance @ 95 v 5×10^{10} ohms; acceleration to 20,000 *G;* vibration 10-55 cps @ 0.06 D.A.; energy transfer 3,000 ergs; operation from −65°F to 160°F. Tubes with other characteristics can be supplied, often from regular production.—*The Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio.*

For more information circle **614** on inquiry card.

ELECTRICALLY-VARIABLE DELAY LINES

New Series EV-600 feature time delay directly proportional to applied voltage, whence (1) infinite resolution over a 50% span of nominal delay value; (2) amplitude function convertible into time modulation of a pulse or phase modulation of a fre-

quency. Delay range 0.50 usec (variable 50% from nominal value); impedance range 50-2000 ohms; delay to rise-time ratio 5:50.—*ESC Corp., 534 Bergen Blvd., Palisades Park, N. J.*

For more information circle **615** on inquiry card.

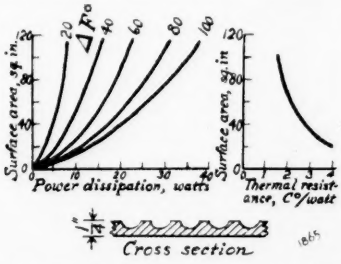
VARIABLE DELAY LINES

New continuously-variable distributed-constant delay lines feature single rotary control providing fine resolution over entire delay range in about 340° rotation. Available in values of: 250 ohms with delay of 0.3 usec, 500 ohms 1.0 usec, and 1000 ohms 1.0 usec.—*PCA Electronics Inc., 16799 Schoenborn St., Sepulveda, Calif.*

For more information circle **616** on inquiry card.

TRANSISTOR HEAT SINK

New heat sink material for power transistors is an aluminum alloy of high thermal diffusivity, extruded to



maximize surface area on one side, and with flat black finish; available in any lengths and widths to 5⅞".—*Optimized Devices, Inc., Box 38, Gedney Sta., White Plains, N. Y.*

For more information circle **617** on inquiry card.

TRANSISTOR AND DIODE RADIATORS

New Heat Radiator 3AL-635, to fit JETEC-30 package, was developed at request of transistor manu-

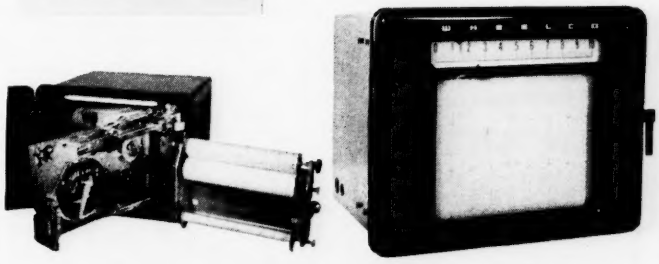
facturers. Black anodized aluminum alloy finned jacket press-fits over transistor case without interfering with operation or servicing. Its dissipation coefficient is 0.28 C°/mw. ★New Diode Radiator 3B640 prevents "thermal runaway" in power transistors; comprises a series of black ebanol finished metallic rings or fins mounted on a plate interposed

THE MARK OF QUALITY

BARBER COLMAN

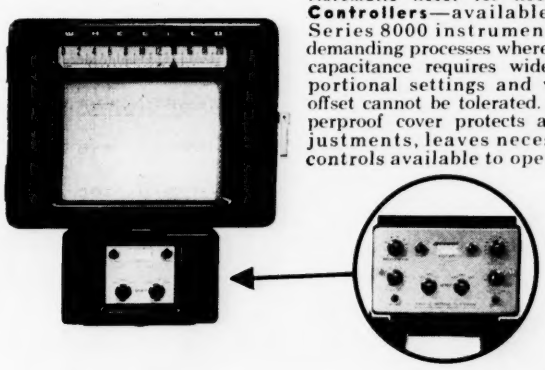
Wheelco Instruments

In recorders and recording controllers ...Wheelco gives you the "extras" that really count



Series 8000 Recorders and Recording Controllers — available in a wide range of models, these self-contained null-balancing electronic instruments feature convenient swingout design for easy chart and instrument maintenance. Multi-point recorders keep permanent records of up to 16 points on a single chart — feature up to six limit switches for high and/or low signal indications . . . single- or multi-color printing . . . 3 to 24 in. per hr recording speeds.

Automatic Reset for Recording Controllers—available with Series 8000 instruments for demanding processes where small capacitance requires wide proportional settings and where offset cannot be tolerated. Tamperproof cover protects all adjustments, leaves necessary controls available to operator.



With Wheelco you get the flexibility of choice that makes a big difference where precision is required in process control. In automatic reset units, for example, four types are available: MP and MMP for fuel-fired installations, MMC for controlling current in electric power setups, and MMD duration-type controller for use with either system. Ask your nearby Wheelco field engineer for more details.

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Industrial Instruments • Automatic Controls • Air Distribution Products
Aircraft Controls • Electrical Components • Small Motors • Overdoors and Operators
Molded Products • Metal Cutting Tools • Machine Tools • Textile Machinery

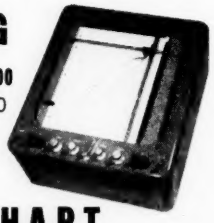
For more information circle **156** on inquiry card.

MANDREL • INDUSTRIAL • INSTRUMENTS

X-Y RECORDING

8½ x 11 paper
10 mv/inch
One second full scale

$520.00
ER-90



STRIP-CHART

Uses electro-sensitive chart paper. Multiple chart speeds. Response to 60 c-p-s, sensitivity 2 mv/mm. Available from one to four channel and as student model.

ER-20

$275.00 per channel for multichannel, $325.00 single channel.

(This unit also available up to 40 channel event recorder)

UTILIZE PRESENT EQUIPMENT

Chopper stabilized d-c pre-amp for meter movement type recorders. 10 mv across 1 megohm produces 1 ma. in 1500 ohms.

$120.00
M-10

Write: MANDREL INDUSTRIAL INSTRUMENTS
Division of MANDREL INDUSTRIES, INC.
P. O. BOX 13243 HOUSTON (19) TEXAS (LOCATED: 5134 GLENMONT DRIVE)

For more information circle **157** on inquiry card.

NORTHAM

MINIATURE TAPE RECORDERS for HIGH FREQUENCY RESPONSE

A REMARKABLE UNIT

Diameter: 5.3", Length: 7.0", Weight: 4.5 lbs. Shock resistance while recording—250 g's axially; 50 g's transversely Ultimate shock without damage—1200 g's

Miniature tape recorder model MR-52 is designed for acquiring essential instrument data in guided missiles, rockets, torpedos, aircraft, as well as commercial applications in oil and chemical processing industries. Tape capacity is up to 10 times that of smaller units, providing longer running times at higher tape speeds, and permitting higher frequency response.

Model 52 is a 7 track recorder with built-in transistorized timing oscillator. Carrier erase, FM carrier, and direct AM recording systems may be employed. Standard tape speed is 15 ips or special tape speeds may be obtained upon request. Write for Bulletin.

Northam Engineering facilities are available to assist you in any application problems.

NORTHAM ELECTRONICS, INC.
2420 N. Lake Ave., Altadena, Calif.

For more information circle **158** on inquiry card.

DON'T DROP THAT SCREW!

Hold it with an H.J.J. Screw-holding Driver

Sizes to handle from #0 to #¼" screws

The H. J. J. COMPANY

268 Marlow Drive • Oakland 5, California

For more information circle **159** on inquiry card.

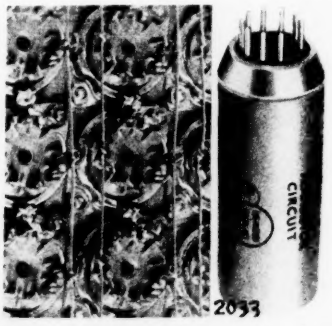
NEW INSTRUMENTS

between diode and mica insulating washer atop chassis. It reduces operating temperature of diodes as much as 30 C° under typical conditions.—*The Birtcher Corp., Industrial Div., 4371 Valley Blvd., Los Angeles 32, Calif.*

For more information circle **618** on inquiry card.

GERMANIUM TRANSISTOR PLUG-IN CIRCUITS

New T Series 250-kc plug-in circuits, using germanium transistors, feature complete inter-circuit com-



patibility; free engineers from burden of routine circuit design. When mounted with recommended 1" spacing, total space required is 1 sq in per case. Eighteen different circuits are available for automatic control, computing, timing, etc.—*Engineered Electronics Co., P.O. Box 659, Santa Ana, Calif.*

For more information circle **619** on inquiry card.

FERRITE DUPLEXER

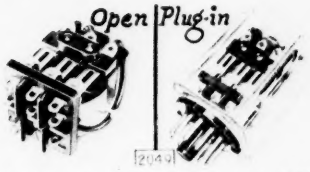
New Model W163-1C-1 Faraday Rotation Duplexer weighs only 7 oz yet offers a frequency range of 9.2 to 9.4 kMc with isolation at 20 db min and insertion loss of 0.5 db max; incorporates a unique coaxial termination to permit both transmission and reception.—*Kearfott Co., Western Div., 14844 Oxnard St., Van Nuys, Calif.*

For more information circle **620** on inquiry card.

relays

GENERAL-PURPOSE RELAY

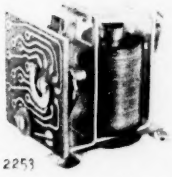
New low-cost MK Series meets UL specs; is available in open and plug-in models (latter in clear or tinted polystyrene housings). Contacts: fine silver or silver cadimium oxide, arrangements up to 3p-dt; rating 5 or 10 amp resistive; coils for all stand-



ard ac and dc voltages and 2,500, 5,000, 10,000 ohms for plate circuit use.—*Line Electric Co.*, 271 *S. Sixth St., Newark 3, N. J.*

For more information circle **621** on inquiry card.

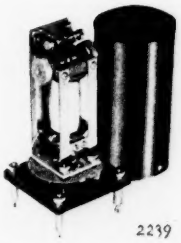
STEPPING RELAY



New SA 12-position stepping relay uses a printed circuit board for switching currents up to 250 ma; can be furnished for ac or dc operation; operates on 3 watts dc or 20 va ac. Armature-driven pawl operates a ratchet to drive a movable arm in steps of 30° over 12 non-shorting printed circuit strips.—*Potter & Brumfield, Inc., Princeton, Ind.*

For more information circle **622** on inquiry card.

POLARIZED RELAY



New P215( ), equal to Western Electric 215, has reed type armatures; mounts by an 18-B connecting block. Resistances up to 1400 ohms single windings or parallel windings of 825 ohms each. Sensitivity as low as 20 microwatts. Extra-heavy palladium-copper armature contacts; adjustable polepiece gap; sp-dt with anti-chatter feature.—*Kurman Electric Co.*, 191 *Newel St., Brooklyn 22, N. Y.*

For more information circle **623** on inquiry card.

electromechanical components

MOTOR BRAKE

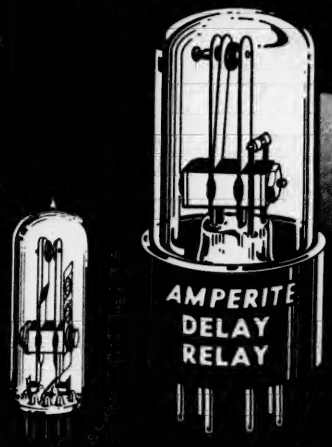
New Style HTC 50 Series Brake for use with fhp motors in frames 56-C and 66-C, also integral motor frames 182 and 184, retains maker's basic single-

AMPERITE PREFERRED

by design engineers—because they're

MOST COMPACT • SIMPLEST • MOST ECONOMICAL

HERMETICALLY SEALED



Thermostatic DELAY RELAYS

2 to 180 Seconds

Actuated by a heater, they operate on A.C., D.C., or Pulsating Current.

Hermetically sealed. Not affected by altitude, moisture, or climate changes.

SPST only—normally open or closed.

Compensated for ambient temperature changes from —55 to + 70 C. Heaters consume approximately 2 W. and may be operated continuously. The units are **rugged, explosion-proof, long-lived,** and—**inexpensive!**

TYPES: Standard Radio Octal, and 9-Pin Miniature. **List Price, $4.00.** Standard Delays

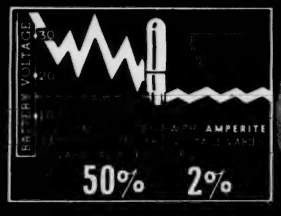
Also — **Amperite Differential Relays:** Used for automatic overload, under-voltage or under current protection.

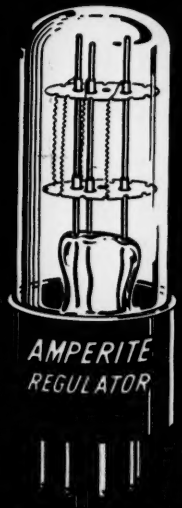
PROBLEM? Send for Bulletin No. TR-81

BALLAST REGULATORS

Amperite Regulators are designed to keep the current in a circuit **automatically regulated** at a definite value (for example, 0.5 amp.)

For currents of 60 ma. to 3 amps. Operate on A.C., D.C., or Pulsating Current.





Hermetically sealed, they are not affected by changes in altitude, ambient temperature (—55 to + 90 C.), or humidity. Rugged, light, compact, most inexpensive. **List Price, $3.00.**

Write for 4-page Technical Bulletin No. AB-51

AMPERITE CO. Inc., 561 Broadway, New York 12, N. Y.

Telephone: CAnal 6-1446

In Canada: Atlas Radio Corp., Ltd., 50 Wingold Ave., Toronto 10

For more information circle **160** on inquiry card.

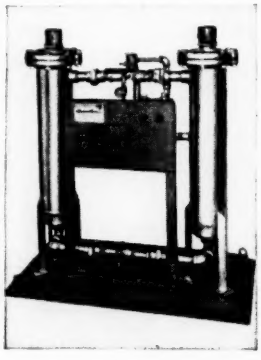
NOW! KAHN offers the NEW!

KAHN HEATLESS DESICCANT AIR DRYERS

Reactivated without heat

Check these advantages:

- Costs reduced on installation and maintenance.
- Steam and electric heaters eliminated . . . reducing utility costs.
- Constant outlet gas temperatures.
- Explosion proofing eliminated.



It's
KAHN DRYERS
all the way . . .

Kahn has a complete line of electric or steam regeneration dryers - automatic, semi-automatic or manual operative. Operating pressures up to 5,000 psi.

Write for complete information.

Kahn and Company, Inc. 543 WINDSOR ST. HARTFORD 1, CONN.

For more information circle **161** on inquiry card.

Established 1847

QUALITY . . **OVER 100 YEARS** . . PROGRESS

Glass . . . ALL TYPES

PRECISION EXECUTION

For instrument dials and other industrial and technical uses

CLEAR COLORED SAFETY TEMPERED
HEAT RESISTING MALTESE NON-REFLECTING GLASS
INSTRUMENT LENSES PILOT LIGHT LENSES

Mirrors . . .

"EVABRITE" FIRST SURFACE MIRRORS — High reflecting hard metal coatings—direct reflection without parallax.

"EVALAST" Mirrors—silver backing protected by electroplating of copper—Eliminates deterioration through moisture, etc. Conforms to Government specifications.

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For New York—WAtkins 4-2121
For New Jersey—MArket 4-5328

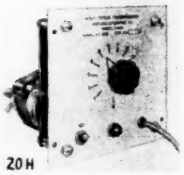
For more information circle **162** on inquiry card.

NEW INSTRUMENTS

solenoid lever-action and unitized construction. Available for all standard ac voltages.—*Stearns Electric Corp., 120 N. Broadway, Milwaukee 2, Wis.*

For more information circle **624** on inquiry card.

MOTORIZED GEAR BOX

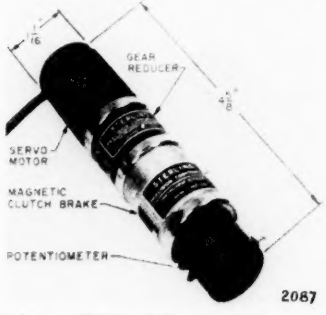


New Model 600 Multi-Speed Gear Box for instrumentation service allows instant selection of any of twelve output speeds covering a 5000 to 1 range (1 rpm to 0.0002 rpm). High-torque synchronous gearhead motor insures accurate speeds. Overload clutch and Nylon output coupler included.—*The Harvard Apparatus Co., Inc., Dover, Mass.*

For more information circle **625** on inquiry card.

SERVO PACKAGE

New Model T-950 combines servomotor, geared reducer, magnetic clutch-brake and voltage-dividing pot



resistor. Motor drives pot arm at a speed corresponding to rotation of a radar scanning antenna, (about 40 rpm).—*Sterling Precision Corp., 34 17 Lawrence St., Flushing 54, N. Y.*

For more information circle **626** on inquiry card.

connectors, etc.

CABLE ARMOR

New Radiation Zippertubing protects cables, wires and controls against nuclear radiation; is made of lead-

saturated glass cloth with a vinyl surface; also provides a waterproof covering that can be zipped off and

destroyed when radiation-saturated; is far easier to install than conventional cable and wire jacketing. Normal wall thickness 0.015"; all sizes from ⅜" ID up, in increments of ⅛" and in lengths from 25 ft.—*The Zippertubing Co., 752 S. San Pedro St., Los Angeles 14, Calif.*

For more information circle **627** on inquiry card.

PRINTED CIRCUIT TERMINALS

New #2228 and #2420 printed circuit terminals are precision-machined in brass and finished with copper flash and 0.0003" tin-lead solder plating; are push-fit with over-knurl and fine straight knurl; satisfy military specs.—*Cambridge Thermionic Corp., 445 Concord Ave., Cambridge 38, Mass.*

For more information circle **628** on inquiry card.

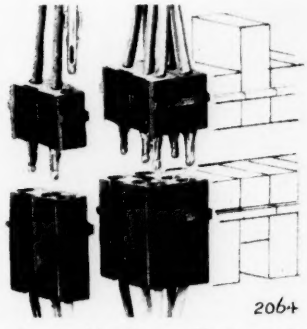
HEADERS AND RECEPTACLES

New hermetically sealed headers and AN-type receptacles are available with white ceramic material contact identification lettering "baked" into compression-sealed glass dielectric.—*Amphenol Electronics Corp., Chicago 50, Ill.*

For more information circle **629** on inquiry card.

PLUG AND RECEPTACLE

New modular units provide "tailor-made" flexibility at low cost for multiple circuit connections: 3 to 30



circuit combinations. Each module provides connections for three circuits with positive polarization; additional polarization easy.—*Molex Products Co., 9215 Southview Ave., Brookfield, Ill.*

For more information circle **630** on inquiry card.

WIRING DEVICES

New Polarized and Turnlok lines both comprise wide ranges. Polarized line offers matched devices for all

SANDERS FLEXPRINT® WIRING

New flexible printed wiring sharply reduces weight, bulk and cost of electronic and electrical assemblies.

Sanders Flexprint Wiring brings to *commercial and military applications* a combination of field-tested advantages unmatched by conventional wiring and ordinary printed circuits.

- Completely flexible . . . exactly reproducible.
- Available in all lengths and current carrying capacities.
- Permanently-bonded in insulating plastics to meet environmental and reliability requirements.
- Weighs less than half as much as conventional wiring . . . occupies less than one third the space.
- Can be easily cut, stripped, and connected.
- Available in vinyls, polyethylenes, polyesters, silicones, Kel-F, Teflon, or other insulations.

Samples and literature available at our booth, or write, outlining your requirements.

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Now, from one source, a complete line of servo valves . . . plus qualified systems engineering . . . for all industrial, marine and aircraft applications.

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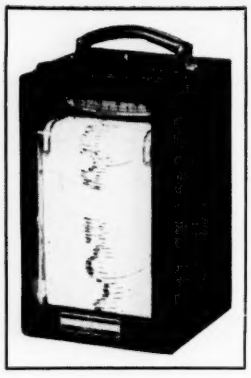

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● **HIGH CURRENT**—and voltage-handling capacity (up to 5 amperes, and up to 500 volts).

● **CHATTER FREE:** Mercury dampens armature vibration and bridges mechanical chatter between metal contact surfaces.

WESTERN ELECTRIC D168479: (Equivalent to 275C); SPDT; 2 coils: 3300 and 700 ohms; High pressure sealed; Octal plug base. Operating current: Windings in series, 6.6 ma. release: 5.2 ma. ..... #R1022 ..... 8.75*

C P CLARE HGP-0:0: SPDT, Double Break (1W); 2 coils—1020 and 970 ohms; high pressure; hydrogen sealed; octal plug base. Operates with 15 ma on either coil; magnetic bias for operation between narrow limits; ..... #R1026 ..... 8.75*

PHASE SHIFT CAPACITORS
WESTERN ELECTRIC
#D150734:

Sig Corp. Stock #2C 6996; =1053A C2. Variable, air-coupling between 4 plates; equal 0.75 to 2.75 mmf, air gap 0.156"; 1⅛" x 2⅛" dia. overall; shaft ⅜" lg. x ¼". For use with BC-1053-A; SCR545A; BC371; SCR 784; Mark 34 and other Radar equipment. W. E. Co. Drawing No's ESO-688147; ESA695412 and 7414822-1 ..... 15.00* ea.

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1-9	as quoted	50-99	15%
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SYNCHROS	PRECISION POTENTIOMETERS
RELAYS	SERVO MOTORS
TUBES	SYNCHRONOUS MOTORS
DIODES	PULSE TRANSFORMERS
METERS	TRANSISTORS

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LISTED BELOW ARE TYPICAL VALUES FROM OUR 16 PAGE BARGAIN CATALOG (AVAILABLE UPON REQUEST)

WINSLOW model 5G-1000 MEGOHMETER—Insulation Resistance Test Set—hand cranked generator—Range 0-1000 megohms at 500 VDC **$129.50**

GENERAL RADIO Type 715AE DIRECT CURRENT AMPLIFIER in portable Esterline Angus case **$250.00**

SOLA #30710 2KVA CONSTANT VOLTAGE TRANSFORMER—Pri—95-125/190-250 V 50 or 60 cy. Sec—115 V ±1% regulation 2000VA **$125.00**

BOSTON Cat. #UD-48 GEAR REDUCTORS—Ratio 48 to 1—0.25 HP at 1800 RPM **$32.50**

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VANDYKE PRECISION POTENTIOMETERS—50K ohms, 10 turns, linearity 0.5%, hermetically sealed **$8.50**

115-Volt 60-cy Synchros

Type 1G Generators	$37.50
Type 1F Motors	37.50
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Type 3HG Generators	62.50
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Type 3HCT Control Transformers	62.50
Type 3D Differential Motors	62.50
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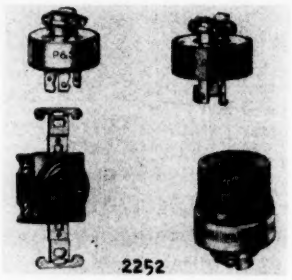
NEW INSTRUMENTS



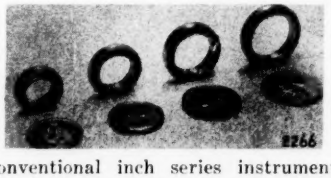
locations requiring polarized connection; 10- to 50-amp ratings; 2-, 3- and 4-wire single and duplex receptacles with and without metal box covers; full line of caps, connector bodies, cord sets, etc. Turnlok Devices insure positive contact regardless of vibration, yet can be disconnected by a slight turn of the cap; 10- and 20-amp ratings; 2-, 3- and 4-wire types. —*Pass & Seymour, Inc., Solvay Station, Syracuse 9, N. Y.*

For more information circle **631** on inquiry card.

mechanical components

PRECISION BALL BEARINGS

New thin-cross-section Split Ball-bearing Midget T Series help bridge gap between miniature bearings and

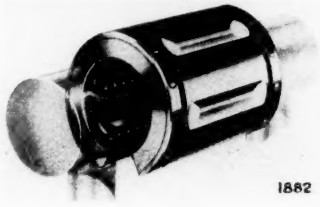


conventional inch series instrument bearings. Some sizes take less than 15% of volume of corresponding bore-size conventional bearings, and ratio of load capacity to unit volume of bearing is much higher. Stock sizes ⅜", ½", ⅝", and ¾"; corresponding OD ¼" greater; width 5/32"; section from bore to OD ⅛" high.—*Split Ball-bearing Div., MPB, Inc., Lebanon, N. H.*

For more information circle **632** on inquiry card.

OPEN LINEAR BALL BEARING

New Open Type Ball Bushings are linear ball bearings that permit use of shaft-support members along



length of shaft traversed by these bearings; provide extreme rigidity or permit unusually long shafts; cut costs where an inexpensive precision ball-bearing way replaces expensive sliding ways. Standard shaft diameters from 1" to 4".—*Thomson Industries, Inc., Manhasset, L. I., N. Y.*

For more information circle **633** on inquiry card.

LINEAR INSTRUMENT BEARING

2091

New Inst-4812 Ball Bushing has been developed for supersensitive applications. Since forces perpendicular to its axis cannot cause linear motion, it enables accelerometer designs with extremely low "cross-talk." Recirculating ball principle provides unlimited travel, whence widest ranges for instruments. Bore dia 0.2500"; rolling load rating 13 lb; static load rating 22 lb.—*Thomson Industries Inc., Manhasset, L. I., N. Y.*

For more information circle **634** on inquiry card.

HINGED CLAMP

2077

New hinged clamp simplifies replacement of damaged split-hub clamps: permits direct placement of clamp over hub so that a replacement which formerly may have taken an hour or more can be made in less than a minute.—*Commercial Products Dept., Reeves Instrument Corp., 207 E. 91 St., New York 28, N. Y.*

For more information circle **635** on inquiry card.

ADJUSTABLE CAMS

New cams are made in two sections which can be spread out fanwise to adjust percent of switch closure. Setting is locked by hex nut. Hubs are bored through to permit ganging. Stock sizes from 1¼" to 3" with bores of 9/32", ⅛", 3/16", ¼", and ⅜".—*Soundtronics Labs, 630 Arch St., Philadelphia 6, Pa.*

For more information circle **636** on inquiry card.

ADJUSTABLE CAM ASSEMBLY

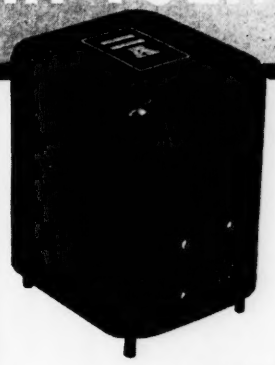
2086

New Model T-199 adjustable cam assembly, for servomechanisms where desired to actuate switches and similar devices at predetermined angular limits, permits ad-

REGULATED DC POWER SUPPLIES

HI-VOLTAGE SERIES

Designed for powering airborne electronics equipment under the most adverse environmental conditions, Arnoux High Voltage DC Power Supplies assure the utmost in reliability. These magnetic-amplifier regulated supplies are available in the range of 108 to 450 volts DC, with current ratings from 50 ma to 800 ma. Other ratings are also available on special order.


Model 250 S 025

ARNOUX

Input Power: 115 volts, 400 cps

Regulation:	Input (Variation)	Output (% Rated)
Line Voltage:	± 10%	± 0.25
Line Frequency:	± 20 cps	± 0.1
Load Current:	20-100%	± 0.1
	0-100%	± 0.2

Ripple: Less than 0.05% rms at full load

Output Adjustment: 5% adjustment available on request at slightly higher price

Environmental: Meets specification MIL-E 5272A for acceleration, vibration, altitude, humidity and temperature operating at 20% to 100% rated load
Also meets MIL-I 6181 B

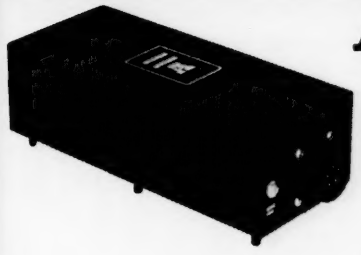
Connector: AN-type connector

Mounting: Stud-mounted

(Write for Bulletin 200)

LO-VOLTAGE SERIES

Intended for use in precision airborne instrumentation systems, Arnoux Low-Voltage DC Power Supplies are available in both single and dual output. Ranging from 5 to 50 volts at currents up to 10 amperes, these rugged units are hermetically sealed.


Model 5 S 10

ARNOUX

Input Power: 115 volts, 400 cps

Regulation:	Input (Variation)	Output (% Rated)
Line Voltage:	± 15 volts	± 0.10
Line Frequency:	± 20 cps	± 0.15
Output Load:	20-100%	± 0.05
	0-100%	± 0.10

Temperature Stability: 0.5% per 100°F. (— 60°F. to + 160°F.)

Ripple: Less than 0.1% rms at full load.

Output Adjustment: Screwdriver adjustment provides ± 0.5 volt change. Wider range of adjustment available on request

Connector: Standard AN-type connector, or hermetically sealed header on request

Mounting: Stud-mounted.

Environmental: Meets specification MIL-E 5272A for acceleration, vibration, altitude, temperature and humidity.

(Write for Bulletin 100)

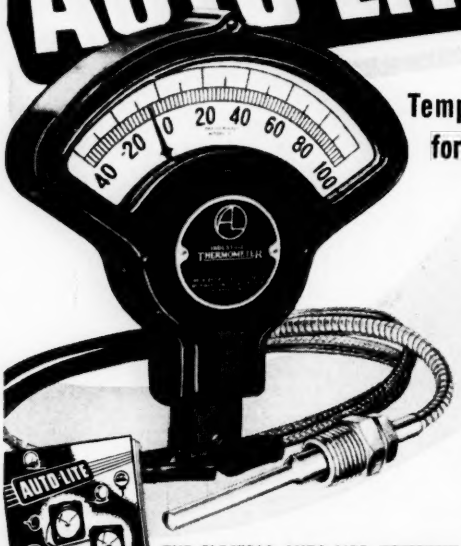
Designers and Manufacturers of
PRECISION INSTRUMENTATION

ARNOUX CORPORATION

11924 WEST WASHINGTON BLVD. • LOS ANGELES 66, CALIFORNIA

For more information circle **167** on inquiry card.

AUTO-LITE



Temperature Indicators for REMOTE READING

Model F-1 temperature indicators are widely used in the chemical and food industries to cut waste and help preserve quality standards in processing and storage. Ideal for installation on any equipment where accurate temperature is desired.

Solid liquid-filled movement . . . Large, easy-to-read dial . . . Equipped with 3-way adjustable bracket . . . Flexible tubing for remote reading or rigid stem for direct mounting . . . Wide choice of standard temperature ranges, from minus 60°F to plus 750°F. From $23.50.

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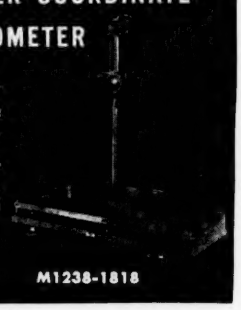
GAERTNER COORDINATE CATHETOMETER



Makes coordinate measurements in a vertical plane—
Cuts inspection time!

Two dimensions are measured with one setting, object does not have to be rotated. Inspection time is cut in half and resetting errors eliminated. Instrument is convenient, reliable, precise.

Ideal for precise measurements on large objects; and objects or points in recessed, remote, or inaccessible locations. Applications: Measuring jet engine sections, complicated castings, printed circuits, bolt holes and bosses on large piece parts, etc.

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For more information circle **170** on inquiry card.

NEW INSTRUMENTS

justment between rise from 0° to 180°. Maximum diameter 1⅛"; hubs available for ⅛", ⅜" and ¼" shafts. —*Sterling Precision Corp.*, 54-17 *Lawrence St., Flushing* 54, *N. Y.*

For more information circle **637** on inquiry card.

DIALS, VERNIERS, ETC.

New Standard Precision disk dials, ring dials, drum dials, verniers, hubs and knobs combine high accuracy and

low cost. Many sizes, styles of graduations, and finishes.—*Ackerman Engravers*, 458 *Broadway, New York* 13, *N. Y.*

For more information circle **638** on inquiry card.

valves, etc.

VIBRATIONLESS VALVES

New Type T full-port normally-closed solenoid valves, for applications that demand hum-free vibrationless operation, handle steam, liquids and gases not injurious to bronze, at temperatures up to 400°F. Sizes from ½" to 3"; valve port areas are equal to nominal pipe size. Solenoid is operated through a rectifier supplied with valve.—*Magnatrol Valve Corp., Hawthorne, N. J.*

For more information circle **639** on inquiry card.

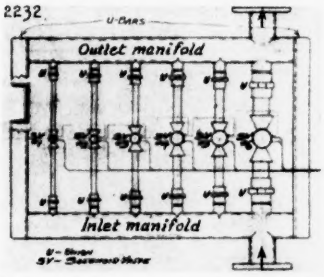
CORROSION-FREE VALVES

New SV-5100 Series all-plastic corrosion-resistant solenoid valves feature no metal contact with fluid, max current drain of 10 watts max @ 115 vac; can be taken apart for cleaning and inspection without removing from lines.—*Valcor Engineering Corp.*, 365 *Carnegie Ave., Kenilworth, N. J.*

For more information circle **640** on inquiry card.

DIGITAL-INCREMENT VALVE

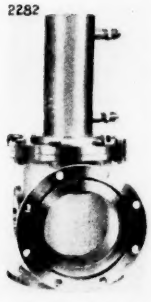
New Digital Regulating Valve achieves close control to one part in 16, 32, 64 (illus.), 128, 256, 1024 or



2048, without costly complicated servo devices. It operates directly from modern digital-output instruments. For application to continuous-variable instruments it only requires a simple analog-to-digital converter. For manual remote control, a set of two-position switches suffices. Available sizes: ½" to 6" inlet & outlet, for steam, gases and most liquids. —*Ferguson, Hille & Associates, 542 S. Dearborn St., Chicago 5, Ill.*

For more information circle **641** on inquiry card.

HIGH-VACUUM VALVE

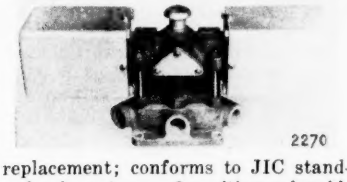


New 4" Type 400 is added to maker's line of high vacuum (to 10^{-7} mm Hg) valves; is tight with atmosphere on either side of seat and can be opened with atmosphere on top of seat. Air-operated version comes with or without solenoid control valves. Design permits vacuum actuation by vacuum from a small pump. It is the only 4" valve available which offers easy conversion from power to hand operation and vice versa.—*Veeco Vacuum Corp., 86-P Denton Ave., New Hyde Park, L. I., N. Y.*

For more infromation circle **642** on inquiry card.

PLUG-IN SOLENOID VALVE

New Model P/N 220155 electrically-actuated pneumatic valve plugs-in for easy servicing and less-than-1-minute



replacement; conforms to JIC standards; is a 4-way, 3-position solenoid-actuated unit rated at 100-psi service pressure and operating on 115 v 60 cps. It has been tested for several million cycles of operation without

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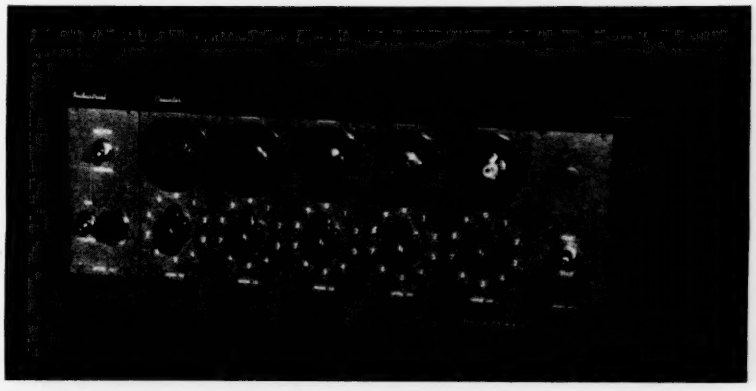
SUPER-FAST, HIGH PRECISION

INDUSTRIAL COUNTING and CONTROL

WITH BAIRD-ATOMIC ELECTRONIC COUNTING INSTRUMENTS



Many standard and special models available for counting, sorting, machine cycle, unit flow, packaging and other industrial and control applications.

Electronic speed and accuracy with up to 20,000 unit counts per second. DEKATRON* cold-cathode glow transfer tubes give constant visual reference to total count.

DEKATRON* TUBES AVAILABLE SEPARATELY

The DEKATRON cold-cathode glow transfer counting tube used in B-A instruments requires far less power than "hot" tubes. DEKATRON tubes permit simplified circuitry with fewer components than ordinary tubes resulting in greatly increased reliability. The moving glow spot within the tube indicates total and eliminates the need for additional indicating lights. Baird-Atomic is the sole distributor of DEKATRON tubes in the United States and Canada.

COMPLETE PLUG-IN STRIPS FOR CUSTOMER ASSEMBLY

Unitized plug-in strips with DEKATRON tube, numbered bezel and drive circuitry are available in many functional types. These B-A plug-in strips save assembly time and permit the customer to more easily incorporate the counter into existing panels or equipment.

*Patented.

Baird-Atomic, Inc.

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Baird Atomic

For more information circle **171** on inquiry card.

specialized keyboards

Any number of keys in any arrangement you require – wired to your specifications – in a rugged steel case.

Concord Keyboards are particularly designed for reliable operation and specialized layout. Each key operates two normally open and two normally closed contacts simultaneously for maximum circuit flexibility. Key activated switches are rated for over 20 million cycles. Key action is positive, no adjustment or lubrication is necessary.

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Send us a sketch of your desired key layout and wiring specifications. We'll send you an estimate by return mail.

Concord Control Inc.
1282 Soldiers Field Road, Boston 35, Mass.
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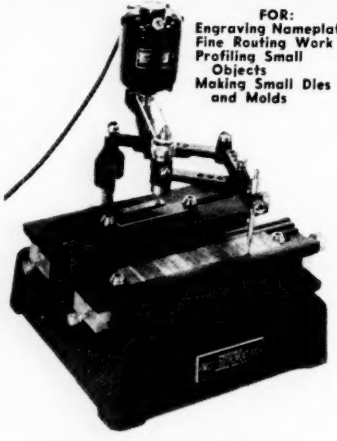
MICO

New Heavy-Duty 2 & 3 Dimensional Engraver



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Fine Routing Work
Profiling Small Objects
Making Small Dies and Molds

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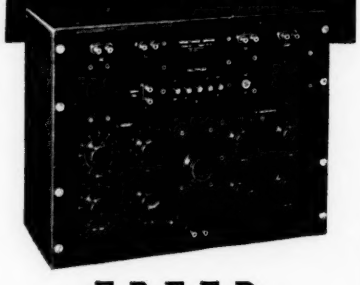

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1110-AB INCREMENTAL INDUCTANCE BRIDGE
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- **"Q"** — 0.5 to 100
- **SUPERIMPOSED D.C.** — Up to 1 Ampere
- **DIRECT READING** — For use by unskilled operators.

ACCESSORIES AVAILABLE:
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1210-A Null Detector - V.T.V.M.
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Send for NEW 48 page transformer catalog. Also ask for complete laboratory test instrument catalog.

FREED TRANSFORMER CO., INC.
1707 WEIRFIELD ST., BROOKLYN (RIDGEWOOD) 27, N.Y.
For more information circle **174** on inquiry card.

NEW INSTRUMENTS

malfunctioning. Port sizes are ½" NPTF dry seal throughout.—*Whittaker Controls Div., Telecomputing Corp., 915 N. Citrus Ave., Hollywood, Calif.*

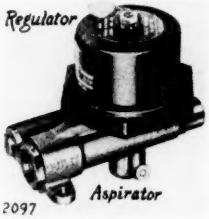
For more information circle **643** on inquiry card.

SAMPLING VALVE

New Sliding Gate Sampling Valve, for drawing off fluid samples for examination or lab test, features self-cleaning seat, self-closure, and no packing. Available in bronze, cast iron, Monel or aluminum bodies; stainless steel trim; ¼" and ⅜" sizes; pressure ratings to 200 psi.—*Jordan Industrial Sales Div., OPW Corp., 6013 Wiehe Rd., Cincinnati 13, Ohio.*

For more information circle **644** on inquiry card.

SELF-REGULATING RELIEF VALVE AND ASPIRATOR

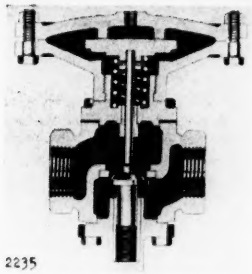


New A-60203 assembly combines in one unit a hydraulic aspirator or jet pump, a pressure-sensitive shut-off-valve and a check valve; functions to boot-strap pressurize a hydraulic reservoir and pump suction by use of pump discharge pressure, features low weight (1.05 lb) low oil flow (0.55 gpm—only during pressurization), zero leakage checking action, filtered air and oil inlets and only two moving parts. Operating temperatures —65°F to 275°F. ★An aspirator and check valve combination, without shut-off feature, is also available.—*Vinson Mfg. Co., 8044 Woodley Ave., Van Nuys, Calif.*

For more information circle **645** on inquiry card.

DIAPHRAGM VALVE

New Diaphragm Valve, with maker's Direct Operated Solenoid Valve as a pilot, provides automatic or remote flow control for pressures to 250 psi. Valve seat is separate from



2235

push rod and is free to float to a tight seat; valve is guided from overhead by an oversize stem fitted within a bronze bushing. Sizes 2", 2½" and 3", all screwed connections; particularly suited for heavy viscous liquids.—*Johnson Corp., Three Rivers, Mich.*

For more information circle **646** on inquiry card.

miscellaneous

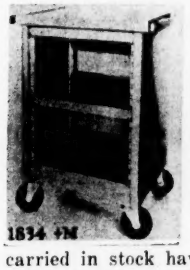
1873

RACK SUPPORTS, SHELVES, ETC.

New vertical side supports and accessories are available in nine sizes to fit maker's Heavy Duty Transmitter Racks. Also available are side mounting brackets and shelves to fit racks 18" deep, 24" deep and 19", 24" and 30" panel spaces.—*Premier Metal Products Co., 337 Manida St., New York 59, N. Y.*

For more information circle **647** on inquiry card.

MOBILE RACKS



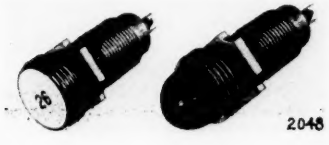
1834 +M

New Model EZ-58 Rackmobile meets RETMA and MIL Specs, transports delicate electronic gear with complete safety from shock and vibration. Two sizes: 38" and 68" high; standard models carried in stock have 18" depth and polished 18" x 24" birch top. Options: standard blank louvered panels; forced air cooling.—*Esco Mfg. Co., 6989 Joliet Road, La Grange, Ill.*

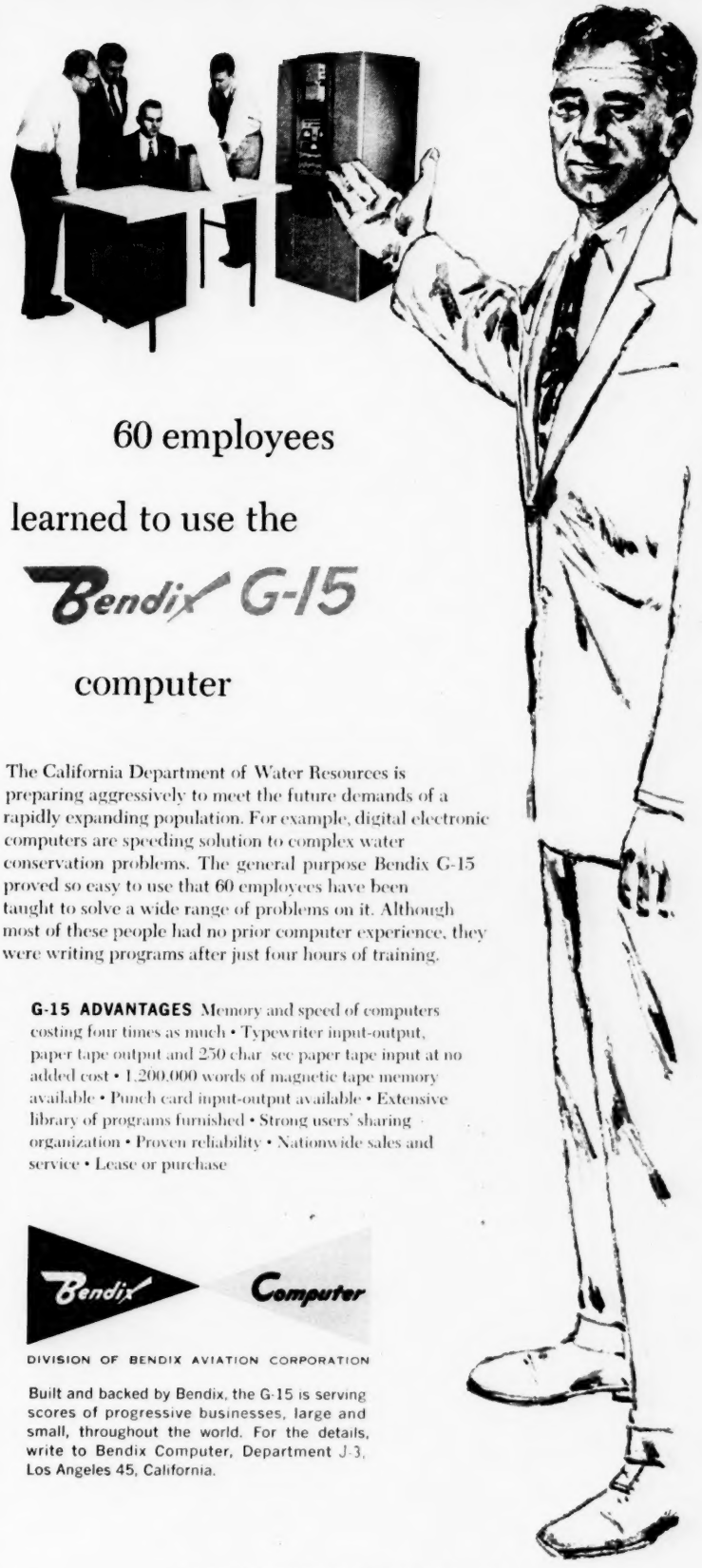
For more information circle **648** on inquiry card.

INDICATING LAMPS

Two new indicating lamps, (No. 150 left; 160 right), Underwriters listed for use with S6 115-v bulbs,



2048



60 employees

learned to use the

Bendix G-15

computer

The California Department of Water Resources is preparing aggressively to meet the future demands of a rapidly expanding population. For example, digital electronic computers are speeding solution to complex water conservation problems. The general purpose Bendix G-15 proved so easy to use that 60 employees have been taught to solve a wide range of problems on it. Although most of these people had no prior computer experience, they were writing programs after just four hours of training.

G-15 ADVANTAGES Memory and speed of computers costing four times as much • Typewriter input-output, paper tape output and 250 char/sec paper tape input at no added cost • 1,200,000 words of magnetic tape memory available • Punch card input-output available • Extensive library of programs furnished • Strong users' sharing organization • Proven reliability • Nationwide sales and service • Lease or purchase

Bendix Computer

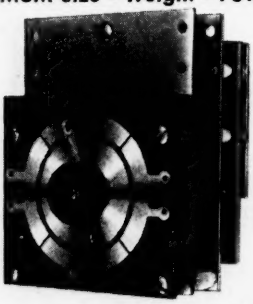
DIVISION OF BENDIX AVIATION CORPORATION

Built and backed by Bendix, the G-15 is serving scores of progressive businesses, large and small, throughout the world. For the details, write to Bendix Computer, Department J-3, Los Angeles 45, California.

For more information circle **175** on inquiry card.

HIGH ALTITUDE
BALLOON
CONTROL INSTRUMENTS
require MAXIMUM Performance
MINIMUM Size - Weight - Power Drain

Brailsford AGC Timers Are Unmatched In These Basic Requirements



Model AGC

If You Have A Timing Problem Where Size, Mass and Power Drain Are Critical Read These

SPECIFICATIONS

Number of decks—1-4 • Speed regulation—±1.0% at 50% voltage shift
Size—1¾" x 2¼"—depth depends on number of decks
Segments per deck—2-8 for stock units.
Special commutators to order for a nominal tool charge.
Shorting or non-shorting contact • Power input—.008 Amp. at 6 VDC

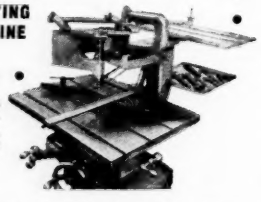
WRITE FOR LITERATURE
BRAILSFORD & CO. INC.
670 MILTON ROAD • RYE, N.Y.

ENGINEERING DEVELOPMENT SUB FRACTIONAL WATT D.C. MOTORS
BRAILSFORD
MANUFACTURING SIGNALLING SYSTEM COMPONENT

For more information circle 176 on inquiry card.

how to ENGRAVE PANELS & SIGNS to 30" wide by any length
Use the LOW COST precision built PREIS-PANTO 2D-4

ENGRAVING MACHINE



It does the work of larger machines, costing much more.

- Pantograph is graduated with reductions from 1:1 to 100:1 and will reduce to any size to infinity.
- Pantograph and spindle link joints equipped with precision ball bearings throughout.
- Precision ball bearing cutter spindle
- Collet capacity from 1/10" to 1/4" and standard taper shank cutters
- Six spindle speeds—5,000 to 14,000 rpm
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TRADE MARK PANTO

Write for complete details and prices. For immediate attention write directly to manufacturer below. Ask for nearest representative.

H. P. PREIS Engraving Machine Co.
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For more information circle 177 on inquiry card.

Flow Visualization Instrumentation

Schlieren Systems
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Wind Tunnel Optics
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Packaged Systems

Catalog upon request

John Unertl Optical Co.
3551-3555 East Street
Pittsburgh 14, Penna.

For more information circle 178 on inquiry card.

feature flat and dome-type lens for lighted legends and signals. Main bodies are die-cast; brass lens caps are chrome-plated. Legend of flat-lens unit easily centered after body has been mounted.—*H. R. Kirkland Co., 8 King St., Morristown, N. J.*

For more information circle 649 on inquiry card.

POINT LIGHT SOURCE

2220

New compact optical system concentrates light output of high-pressure mercury lamp into small-diameter point of high intensity. Point sizes range from 0.002" to 0.016" diameter. Intensities at these diameters range from 3 to 300 candles, respectively. Beam width is a full 180° hemisphere.—*The deFlorez Co., 116 E. 30th St., New York, N. Y.*

For more information circle 650 on inquiry card.

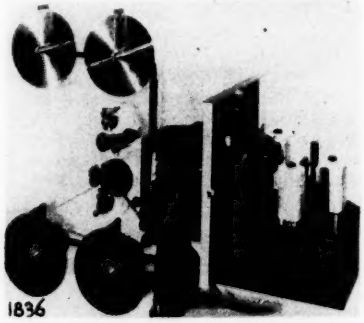
MATH SYMBOLS TEMPLATE

New No. 17 template contains all mathematical symbols, includes numerals, all small letters (and some capitals) of Greek alphabet, parentheses, brackets, root symbols and integrals of various sizes. Over-all size 6¼" x 2½".—*Rapidesign, Inc., Box 429, Burbank, Calif.*

For more information circle 651 on inquiry card.

THREE-LIGHT ADDITIVE COLOR COMPENSATING HEAD

New unit fits existing machines of Depue-Carlson and Andre Debrie Step Printers and Bell & Howell



1836

Models D & J Continuous Printers; supplies discrete blue, green and red beams. Among many features: solenoid-operated calibrated neutral-density glass filters; five filters in each color beam giving 32 printer steps of 0.025 log E.—*Fish-Schurman Corp., 70 Portman Rd., New Rochelle, N. Y.*

For more information circle 652 on inquiry card.

PRECISION CENTRIFUGE

New Universal Centrifuge embodies improvements which provide outstanding table-model performance at an extremely low price; is 22" in diameter and 14" high; handles ½-ml to 100-ml tubes; provides continuously variable speeds to 2250 rpm and precise speed control; has a tough acid-alkali-lacquer-solvent-resistant exterior.—*Precision Scientific Co., 3737 W. Cortland St., Chicago, Ill.*

For more information circle **653** on inquiry card.

TELEFACSI

New Stenotron, said to be "a dramatic new electronic communication device," transmits handwriting or hand-drawn maps, etc. electronically from one point to another over telephone wires or FM radio with a precision of 1/32" in drawings transmitted. In operation, sender writes with a ballpoint pen held by two arms which allow it complete two-dimensional freedom. At receiving station a "slave" ball-point pen writes the same message.—*Autron Engineering, Inc., 2201 Park Drive, Los Angeles 26, Calif.*

For more information circle **654** on inquiry card.

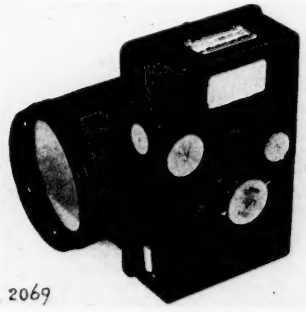
INDUCTION GENERATOR

New 5-kw water-cooled Model L7F low-cost heavy-duty generator, for high-efficiency industrial applications, is constructed to operate with a wide variety of work coils and loads; has continuous power adjustment from 5 kw to 1 kw output; can be set up for completely automatic operation; operates on 240-v single-phase lines; weighs about 500 lb; is contained in cabinet 30" W, 28" D, 40" H.—*Reeve Electronics, Inc., 609 W. Lake St., Chicago 6, Ill.*

For more information circle **655** on inquiry card.

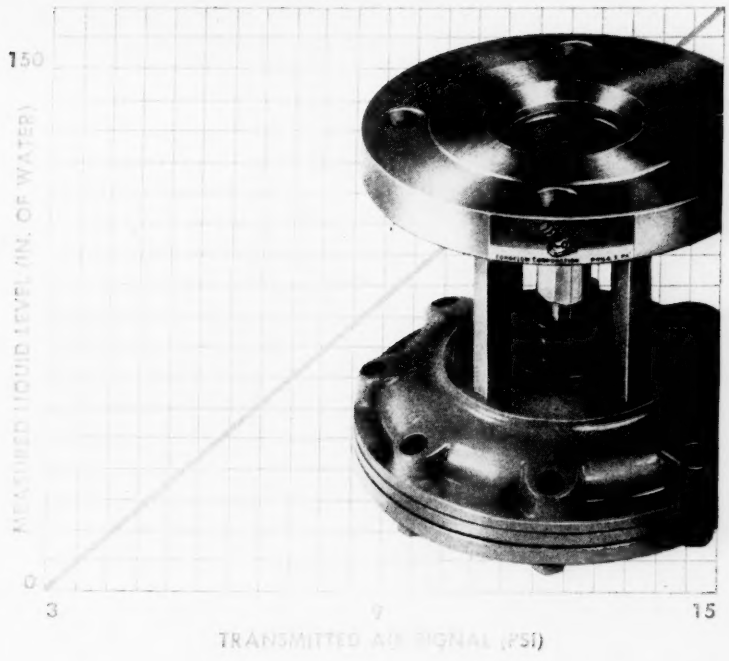
RADARSCOPE CAMERA

New fully-militarized 35-mm Model 205A Recording Pulse Camera photographs once per second the images appearing on face of a 5" CRT through periscope optics. Weight 4½ lb (plus 1½ lb for periscope); 25-mm *f* 1.9 or 40-mm *f* 1.5 lens with focus adjustable from 12" to infinity; film capacity 60 exposures on 35-mm ASA



2069

TYPICAL PERFORMANCE CURVE OF MODEL "P" TRANSMITTER



NEW

CONOFLOW
LIQUID LEVEL & PRESSURE
TRANSMITTER
WITH
Exclusive
ISOLATED MEASURING DIAPHRAGM

The Conoflow Model "P" Transmitter is a rugged instrument which measures pressure and liquid level and transmits a *linear* 3-15 psi signal to standard receiver elements. Incorporates these cost-saving features:

Safety—Process liquids and gases cannot back up through air lines and damage costly instruments. This is guaranteed by the complete separation of measuring diaphragm from pneumatic pilot.

Simple Installation—The Model "P" can be mounted either horizontally or vertically on open or closed vessels. No dip tubes, floats or other mechanical devices are required inside the tank.

Long Life—Only the corrosion-resistant *Inconel X* diaphragm is exposed to the measured material. Preformed diaphragm will not work-harden or fatigue; withstands pressures to 500 psi and temperatures to 450°.

Versatile—Can be used for practically any service; ideal for viscous fluids or materials with solids in suspension; also for flowing bulk materials such as pigments, flakes, etc.

Choice of Ranges—Available for measuring ranges as low as 0 to 100" of water and pressures as high as 250 psi. Ranges can be changed in the field.

Specifications—Bulletin P-2520-3 contains complete specifications on the Conoflow Model "P" Transmitter. Write for your copy today or let us quote on your requirements. No obligation. Conoflow Corporation, 2100 Arch Street, Philadelphia 3, Pa.

CC-802

Conoflow® **CONOFLOW CORPORATION** *FOREMOST IN FINAL CONTROL ELEMENTS* SUBSIDIARY OF WALWORTH

For more information circle **179** on inquiry card.

THE MOSELEY
AUTOGRAF
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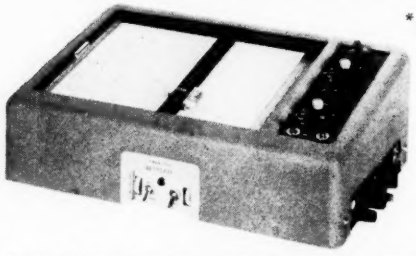
X-Y-Ⓣ* RECORDER
* with TIME BASE



Model 3 S

A new innovation in X-Y Recorders incorporating on the X-axis a TIME BASE or SWEEP CIRCUIT which may be used in numerous applications requiring the plotting of one variable against time. Standard two-variable plotting capability, when desired, is not impaired.

FEATURES
• 5 calibrated time intervals at 5, 10, 50, 100, and 500 seconds for full scale pen travel on X-axis.
• 11 input ranges from 5 millivolts to 500 volts on each axis.
• One-half second full scale recording speed.
• Better than 0.25% accuracy.

Write for complete information

F. L. MOSELEY CO.
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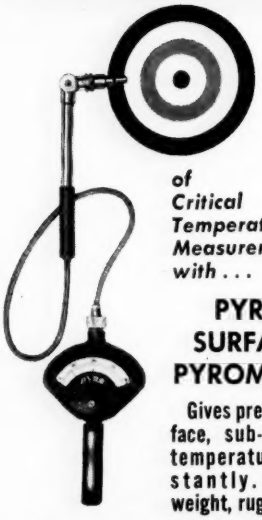
Pasadena, California

For more information circle **180** on inquiry card.

UNEXCELLED ACCURACY



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JAMAICA 35, N. Y.

For more information circle **182** on inquiry card.

NEW INSTRUMENTS

standard cassette; complete data chamber has 3-digit frame counter, 24-hour clock and accessible data card.—*Optomechanisms Inc.*, 216 *E. Second St., Mineola, L. I., N. Y.*
For more information circle **656** on inquiry card.

last-minute items

COLOR FILLING AND PRINTING MACHINE applies color to sunken or raised letters and design, also to raised panels, etc.—The Acromark Co., 3-11 Morrell St., Elizabeth, N. J.
For more information circle **657** on inquiry card.

ULTRASONIC CLEANERS. New Model DR 125AH, a more powerful version of DR 50AH Portable, can drive ¾-gal Model AT 500T tank. New 150-gal capacity DR-2000AH System can clean complete business-machine assemblies, etc.—Acoustica Associates, Mineola, N. Y.
For more information circle **658** on inquiry card.

TC REFERENCE JUNCTION: New miniature multi-channel thermocouple RJ for airborne and test cells replaces ice bath, holds temperature constant within 0.5 deg.—Aero Research Instrument Co., 315 N. Aberdeen St., Chicago 7, Ill.
For more information circle **659** on inquiry card.

MICRO DISPLACEMENT PICKUP. New No. S-2037-2 heavy-duty dial indicator with built-in voltage divider has a measuring range up to 4"; provides both visual and electrical indication of position or motion to 0.001".—B. C. Ames Co., Waltham, Mass.
For more information circle **660** on inquiry card.

MINIATURE RACK & PANEL CONNECTORS have insert arrangements of 34, 42 and 50 removable Poke-Home contacts which can be automatically crimped to wire outside connector body and then inserted.—Amphenol Electronics Corp., 1830 S. 54th Ave., Chicago 50, Ill.
For more information circle **661** on inquiry card.

BALANCING. New Work Orientor attachment automatically positions work for drilling or marking the unbalance of rotating parts on Dynograph Balancing Machine.—R. B. Annis Co., Indianapolis 2, Ind.
For more information circle **662** on inquiry card.

HIGH VOLTAGE TESTERS. New Series 4000 Hypot ac breakdown testers cover ranges from 50,000 to 100,000 vac at capacities of 2 and 5 kva; test equipment and materials in accordance with ASTM and Federal specs.—Associated Research, Inc., 3777 W. Belmont Ave., Chicago 18, Ill.
For more information circle **663** on inquiry card.

PHASE SEQUENCE SWITCH. New Model 454 automatically protects polyphase electrical equipment from damage if connected to line in wrong phase sequence. It can perform any switching, control, or alarm function

desired.—Associated Research, Inc., 3777 W. Belmont Ave., Chicago 18, Ill.

For more information circle **664** on inquiry card.

DUPLEX CLUTCH-BRAKE. New miniature Model MBB comes in 4 sizes in 3 shaft alternates featuring zero backlash, zero end-play, no slip rings, fast response.—Autotronics Inc., Box 812 Rt. 1, Florissant, Mo.

For more information circle **665** on inquiry card.

MAG-AMP CONTROLS. Two new magnetic amplifier systems for use in on-off, proportioning, or pulse-modulated floating temperature control applications, or for remote positioning and synchronizing systems, feature extreme shock and vibration resistance.—Barber-Colman Co., Rockford, Ill.

For more information circle **666** on inquiry card.

SMALL MOTOR. New low-cost precision-made ac motor features long-life alignable bearings ,high starting torque and low noise level; ratings up to 1/150 hp.—Barber-Colman Co., Rockford, Ill.

For more information circle **667** on inquiry card.

HUMIDITY-PROOF POT. New lead-screw-actuated-adjustment Model 236 Trimpot, capable of 135°C operation, employs new Silverweld element termination and ceramic card, maximizing stability and reliability.—Bourns Laboratories, Riverside, Calif.

For more information circle **668** on inquiry card.

TC WELL. New long-life thermocouple well for use where sulfur fumes are present has long life: Up to three years inside a 2-00°F sulfur furnace has been reported.—The Bristol Co., Waterbury 20, Conn.

For more information circle **669** on inquiry card.

STOVE-DOME TC. New LT-1 long-life thermocouple assembly for blast furnace stove domes lasts up to 24 months.—The Bristol Co., Waterbury 20, Conn.

For more information circle **670** on inquiry card.

POWER SUPPLY. New transistorized shock-proof compact (4x2½x2¾") 150 to 250 vdc Model PT-121 weighs 36 oz, features efficiency of better than 90% over operating temperature range from −55°C to 85°C.—Computer Engineering Assoc., Inc., 350 N. Halstead St., Pasadena, Calif.

For more information circle **671** on inquiry card.

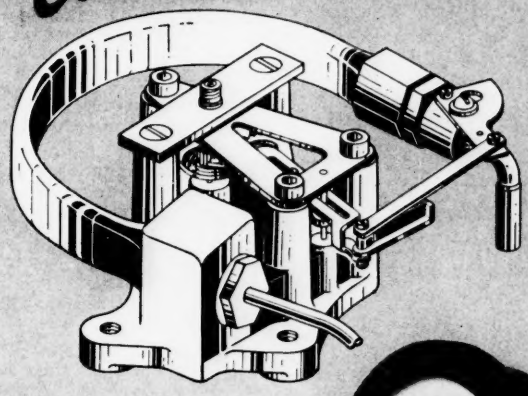
VIBRATION PICKUPS. Three new vibration pickups (Types 4-121, 4-122, and 4-123, for horizontal, vertical and omnidirectional mounting) are particularly suited for in-flight monitoring of jet engines, motors and other constantly vibrating equipment.—Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.

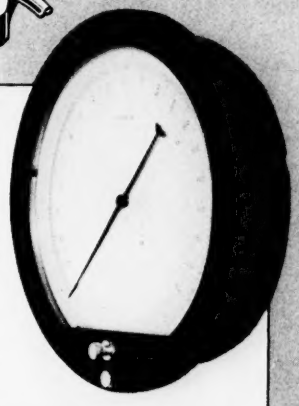
For more information circle **672** on inquiry card.

TWO-STATION VACUUM GAGE. New GGT-100 measures on a single nonlinear scale marked from 0 to 1000 microns Hg, with 5 microns lowest indicated division.—Consol. Electro-

HEISE GAUGES

NEW Automatic Thermal Compensator





Heat and cold have no effect on the Heise High Precision Pressure Gauge equipped with the new Thermal Compensator. (Patent applied for)

Developed by the Heise Laboratories, manufacturers of the world's finest pressure measuring instruments, this unique device now eliminates all error due to thermal variations. Pointer errors caused by linkage growth and changing modulus in the Bourdon Tube are positively and precisely compensated by the equal and opposite action of a scientifically designed and balanced bimetal bar to maintain calibration through a temperature range from 0° to 100°F.

Even exposed to rapidly changing weather outside the confines of the laboratory, the Heise Gauge upholds its traditional position as

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Pressure Ranges 15 to 20,000 P.S.I. Dial Sizes 8½"-12"-16"

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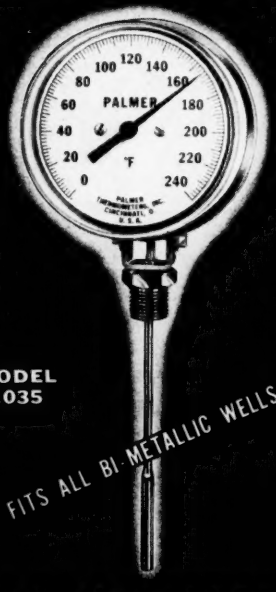
For more information circle **183** on inquiry card.

Outstanding Accuracy

PALMER

Dial Thermometer



Check these functional features

- Direct-drive Bourdon Coil with a filled system for longer lasting accuracy.
- Stem can be placed at any desired angle and case can be rotated to most readable position.
- External calibration for zero setting.
- Unaffected by stem alignment.
- Accurate to one scale division.
- No sticking at any temperature.
- Non-corrosive case.

PALMER

THERMOMETERS, INC.

Mfrs. of Industrial Laboratory, Recording and Dial Thermometers

2515 Norwood Ave., Cincinnati 12, O.

For more information circle **184** on inquiry card.

NEW INSTRUMENTS

dynamics Corp., Rochester Div., 1775 Mt. Read Blvd., Rochester 3, N. Y.
For more information circle **673** on inquiry card.

MINIATURE DC MOTOR. New Type 800 offers excellent speed stability, output speeds from 900 rpm to 2 rpd with gear train and from 960 to 3000 rpm without gear train providing maximum torques of 30 oz-in and 0.6 oz-in respectively.—Cramer Controls Corp., Centerbrook, Conn.
For more information circle **674** on inquiry card.

RADIO TELEMETERING ITEMS. New vacuum-tube-type voltage-controlled oscillator; new transistorized voltage-controlled oscillator; new vacuum-tube-type strain gage oscillator; new transistorized strain-gage oscillator; new tube-type discriminator; new transistorized discriminator; new switchable discriminator tuning unit; and new complete FM/FM ground station.—Data-Control Systems Inc., 39 Rose St., Danbury, Conn.
For more information circle **675** on inquiry card.

DIGITAL TOTALIZER AND READOUT. New Model 7106 Digitote can serve as test-equipment GO/NO-GO indicator, controller, or digital recording output device; accepts 60 pulses per second.—The Digitran Co., 45 W. Union St., Pasadena, Calif.
For more information circle **676** on inquiry card.

TIME DELAY RELAYS. New full-power sp-st, 2p-st and sp-st time delay relays rated at 20, 35 and 60 amp or up to 5 hp at 115 vac, feature sealed mercury-to-mercury snap action.—Ebert Electronics Corp., Queens Village 28, N. Y.
For more information circle **677** on inquiry card.

AUTOMATIC EXTENDED READOUT. New "AERO" instantly allows any point in a problem to be checked visually on 4-digit readout of EAI's digital voltmeter, while this information is printed on paper tape on EAI's new high-speed printer.—Electronic Associates, Long Branch, N. J.
For more information circle **678** on inquiry card.

AUTOMATIC DIGITAL INPUT-OUTPUT SYSTEM. New "ADIOS" permits faster, more accurate setting of automatic servo pots from a keyboard or from pre-programmed punched paper tape.—Electronic Associates, Long Branch, N. J.
For more information circle **679** on inquiry card.

DIAMOND FILE. New riffle file is coated with 90-micron diamond particles permanently bonded in chrome deposit on a hardened steel core; is available in four shapes (cross-sections).—Engis Equipment Co., 431 S. Dearborn St., Chicago 5, Ill.
For more information circle **680** on inquiry card.

DIGITAL VOM. New light-weight transistorized digital volt-ohmmeter has 4 switchable bipolar voltage ranges, 5 switchable resistance ranges, automatic polarity and decimal point indications; can directly drive printers, punches and memory units.—Epsco, Inc., 588 Commonwealth Ave., Boston 15, Mass.
For more information circle **681** on inquiry card.

DECADE COUNTER. New CT-101 transistorized decade counter counts at rates up to 150 kc, has easy-to-read display with ⅜" numerals backlighted on a translucent plastic panel: Only desired digit can be seen.—Epsco Components, 108 Cummington St., Boston, Mass.
For more information circle **682** on inquiry card.

THYRATRON GRID DRIVE. New push-pull all-magnetic full-wave medium-gain thyratron grid drive, incorporating a fast-response mag amp, provides a complete servo amplifier for power levels up to 15 kw; features linear proportional control and 180° range of firing angles.—Fairfield Engineering Corp., 934 Hope St., Springdale, Conn.
For more information circle **683** on inquiry card.

GOVERNOR. New Type 4300 lightweight hydraulic governor of speed-droop lever type controls gasoline or diesel generator sets, trucks, tractors, etc.; uses engine lube oil as pressure medium.—Farris Pickering Governor Co., Inc., 610 Commercial Ave., Palisades Park, N. J.
For more information circle **684** on inquiry card.

SAMPLING SWITCHES. New 1300 Series electronic (no moving parts) multi-channel high-speed sampling switches meet the most exacting MIL specs. Example: Model 1300-a, up to 4 accurately synchronized poles, up to 24 non-shorting channels, size 2x2x3".—General Devices, Inc., P. O. Box 253, Princeton, N. J.
For more information circle **685** on inquiry card.

ULTRASTABLE TRANSISTORS. Four new p-n-p medium-speed switching transistors (2N394, 95, 96 & 97) have less than 20% change in h_{FE} and I_{CO} after 4000 hours at 100°C; are designed for use in digital computers.—General Electric Co., Semiconductor Products Dept., Syracuse, N. Y.
For more information circle **686** on inquiry card.

LAB DRYING OVEN. New low-cost constant-temperature (to 200°C or 400°C) Model LO-200-C with shelves adjustable for height every ½", has thermostat-controlled induced-air circulation. Inside dimensions: 12" wide x 10" x 10". Shipped ready for plug-in.—Grieve-Hendry Co., Inc., 1401 W. Carroll Ave., Chicago 7, Ill.
For more information circle **687** on inquiry card.

PRESSURE PICKUPS. New Series PSG-1 (also known as "Brady Gauges") utilize unbonded strain wire principle; are insensitive to vibration and acceleration. Standard ranges from 25 to 300 psig, psia and psid.—Gulton Industries, Inc., 212 Durham Ave., Metuchen, N. J.
For more information circle **688** on inquiry card.

FILTERING ELEMENTS made of sintered bronze or 316 stainless steel are added to maker's 540 Series Micron Filters. Bronze elements from 5-12 to 150-200 microns; 316 stainless steel

DEPENDABLE
100% AUTOMATIC
REMOTE READING
Tank Contents Gauges

- RELIABLE
- NO POWER REQUIRED
- UNDERWRITERS' APPROVED

Liquidometers use a temperature compensated balanced hydraulic system. Indications unaffected by changes in specific gravity. All models feature large easy-to-read dials. UL approved switches available.

Write for complete details to Dept. E.

Since 1920 ... of proven quality

THE LIQUIDOMETER CORP.
LONG ISLAND CITY 1, NEW YORK
For more information circle **185** on inquiry card.

How to SAVE Your BREATH, MONEY, and do CLEANER PUNCH WORK!

Compressed air, the "breath" of many industrial processes, costs money when wasted, and sometimes, if not used properly, doesn't do the job it could.

For example, on the automatic punch press at left, a continuous stream of air was used originally to keep dies clean. After installing a Clippard Miniature 2-way Air Valve cycled to JET BLAST die scrap between each stroke, work quality was improved, production speeded and air saved.

Clippard Miniature Air Valves (2 and 3-way), Cylinders (many types and strokes) and accessories can save air and money for YOU, and improve your tooling, jigs, fixtures and automated production devices, simply and inexpensively.

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Automation Show June 9-13

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7382-I Colerain Rd., Cincinnati 39, Ohio • Phone: JAckson 1-4261
Manufacturers of R. F. Coils, Electronic Equipment, Miniature Pneumatic Devices
For more information circle **187** on inquiry card.

INSPECTION BY AUTO-COLLIMATION
with the New OPTO TOOLING AUTO-COLLIMATOR

READING DIRECTLY TO ONE SECOND OF ARC... ...AND 5 MILLIONTHS OF AN INCH

NO MOVING PARTS
The light path is traced in this drawing. Dotted lines denote the path of the reflected rays from the mirror in a new position.

The OPTO Tooling Auto-Collimator is the ONLY way to accurately check the angular tolerance of parts and the squareness and perpendicularity relationship of surfaces to each other.

Here is
THE EQUIPMENT THAT DOES ALL THE HARD JOBS

- Testing surface flatness of machine beds
- Checking squareness of surfaces
- Measuring alignment of centers and squareness of axis to ways
- Testing angles on jigs and fixtures
- Checking straightness of bores
- Checking faces for parallelism
- Permanent accurate indexing
- Optical instrument assembly alignment

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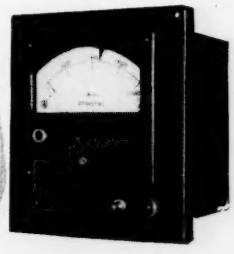
COMPLETE LINE OF PRECISION INSTRUMENTS
200-MG LAFAYETTE STREET • NEW YORK 12, N.Y.

For more information circle **186** on inquiry card.



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PROTECT
MATERIAL and EQUIPMENT
Automatically
with Alnor® PYROTAC

Not expensive... but a simple, automatic way to safeguard your investment in heating equipment and materials in process.

The precision-built Pyrotac constantly indicates temperature of the heated equipment and sounds an alarm and/or shuts down the equipment at a safe, preset temperature. May also be used as a controller on processes where shutdown is required upon reaching final process temperature—such as ceramic kilns, molds, etc. Automatic thermocouple break protection assures complete safety if couple or lead wire should break.

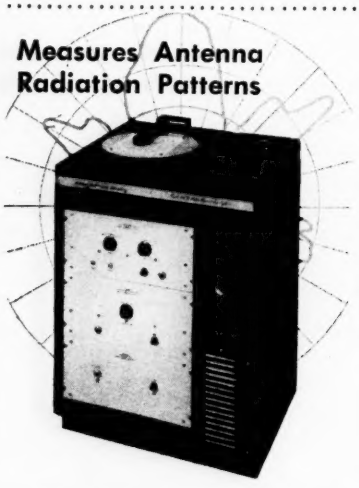
Write for Pyrotac bulletin. Attach this ad to your letterhead, send to: Alnor, Room 518, 420 No. LaSalle St, Chicago 10, Ill.

Alnor PRECISION INSTRUMENTS FOR EVERY INDUSTRY

For more information circle **188** on inquiry card.

TEST INSTRUMENTS for *LABORATORY/PRODUCTION*

Measures Antenna Radiation Patterns



POLAR PATTERN RECORDING SYSTEM

AIL's Type 116R Polar Pattern recording system precisely records directional characteristics of electromagnetic, acoustic, thermal, atomic, and light radiation patterns. It traces, in polar coordinates, a continuous inked plot of input voltage vs angular position.

Precision performance is assured by low internal noise, high sensitivity, accurate turntable drive and exact pen response.

Available accessories include a new automatic relative power computer and a square root amplifier.

Write for details.

AIRBORNE INSTRUMENTS LABORATORY INCORPORATED

1345 NEW YORK AVENUE
Huntington Station, L. I., N. Y.

For more information circle **189** on inquiry card.

NEW INSTRUMENTS

elements from 5-7 to 10-13 microns. Pressure limit 5000 psi; temperatures −600°F to 450°F.—Hoke, Inc., 136 S. Dean St., Englewood, N. J.
For more information circle **689** on inquiry card.

CHECK VALVES. New piston-type Series 570 are added to maker's ball-type line; are available in brass (3000 psi) or type 303 stainless steel (5000 psi), in pipe sizes from ⅛" to ½", also ¼" Swagelok and 37° JIC type flare tubing connectors.—Hoke, Inc., 136 S. Dean St., Englewood, N. J.
For more information circle **690** on inquiry card.

SWEDISH COPYING LATHE. New HKS-2 with 47" center distance can be operated automatically or by hand for up to four machining cycles, not including cut-off; swings 15¾" (over carriage 9⅞"); 20 hp motor.—Homestrand, Inc., Larchmont, N. Y.
For more information circle **691** on inquiry card.

AMPLIFIER. New Model M-220 Dual Channel DC Amplifier, with maker's 2-channel Model GA-1023 Electrodynamic Recorder, provides a portable 2-channel direct-inking or electric recording system with flat writing response from dc to 200 cps.—Massa Laboratories, Inc., Hingham, Mass.
For more information circle **692** on inquiry card.

OSCILLATOR. New Model SC-4 fully transistorized FM subcarrier oscillator is inductance-controlled for use with variable-reluctance pickups; weighs 7 oz. is 3" long, 2" wide, 1" high; will operate from −65°F to 160°F, to 95% relative humidity and to 500 G.—Northam Electronics, Inc., 2420 N. Lake Ave., Altadena, Calif.
For more information circle **693** on inquiry card.

PRESS BRAKE. New Model 20-72 hydraulically-operated 6-ft Press Brake with adjustable stroke is designed for light-gage sheet forming and fabricating operations; features stroke adjustment.—O'Neil-Irwin Mfg. Co., 663 Eighth Ave., Lake City, Minn.
For more information circle **694** on inquiry card.

GEAR PITCH GAGE. New Type CR fine-pitch spur gear checking gage is made with 48, 64, 72, 80, 96 and 120 pitch master checking gears.—PIC Design Corp., 477 Atlantic Ave., E. Rockaway, N. Y.
For more information circle **695** on inquiry card.

AMPLIFIER. New Series 101 high-temperature silicon transistor amplifier delivers 500 mw over wide temperature range, weighs less than 5 oz; occupies only 5 cu in; is suited for driving electrohydraulic valves, etc.—Precision, Inc., 730 Lyndale Ave. N., Minneapolis, Minn.
For more information circle **696** on inquiry card.

VERNIER CALIPER. New Lustro-Chrome Stainless Steel Vernier Caliper takes the glare out of caliper readings, is said to be "the most significant advance in a quarter century of caliper design."—George Scherr Co., Inc., 200 Lafayette St., New York 12, N. Y.
For more information circle **697** on inquiry card.

ELECTRIC CLUTCHES. New FFC-20 fixed-field clutches in small and miniature sizes feature diaphragm as the only moving part; come in three styles: coupling, clutch and coupling-brake. Torque outputs 10 oz-in to 100 lb-in.—Simplatrol Products Corp., 24 Salisbury St., Worcester, Mass.
For more information circle **698** on inquiry card.

DUAL-BEAM 'SCOPE. New Type 502 has two high-gain vertical amplifiers with calibrated sensitivities in 16 steps from 200 uv/cm to 20 v/cm; frequency response dc to 100 kc at max sensitivity.—Tektronix, Inc., P. O. Box 831, Portland 7, Oregon
For more information circle **699** on inquiry card.

TV WAVEFORM GENERATOR. New Model 1003-C produces multifrequency burst, starstep, modulated stairstep, window and sync signals.—Telechrome Mfg. Corp., 28 Ranick Drive, Amityville, L. I., N. Y.
For more information circle **700** on inquiry card.

SUBCARRIER OSCILLATOR. New subminiature Model 800-C for missiles is said to be the most stable, and ultralinear oscillator for telemetering systems.—Telechrome Mfg. Corp., 28 Ranick Drive, Amityville, L. I., N. Y.
For more information circle **701** on inquiry card.

RF AMPLIFIER. New Model 1466-A provides 100 watts out from 2 watts drive; withstands missile environmental conditions.—Telechrome Mfg. Corp., 28 Ranick Drive, Amityville, L. I., N. Y.
For more information circle **702** on inquiry card.

DIODE AND TRANSISTOR TESTER. New Model BT 5001A measures saturation currents over six voltage ranges from 0-10 to 500-750 and fourteen current ranges with keyboard selectivity from 10^{-9} to 10^{-3} amp full scale.—Trans Electronics, Inc., 7349 Canoga Ave., Canoga Park, Calif.
For more information circle **703** on inquiry card.

TEMPERATURE CONTROLLER. New Type D98A is explosion-proof dual switch remote-bulb unit for use in hazardous locations.—United Electric Controls Co., 79 School St., Watertown Mass.
For more information circle **704** on inquiry card.

POWER SUPPLY. New Crow Model 620-R 4-Station ac-dc Student Power Supply allows any shop workbench to be converted to an electrical bench; can be used by eight students at a time—Universal Scientific Co., Inc., Vincennes, Ind.
For more information circle **705** on inquiry card.

RADIATION MONITOR. New Model 743 Combination Radiation Alarm Monitor and Rate Meter provides continuous visual and audible indication of radioactivity levels.—The Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio.
For more information circle **706** on inquiry card.

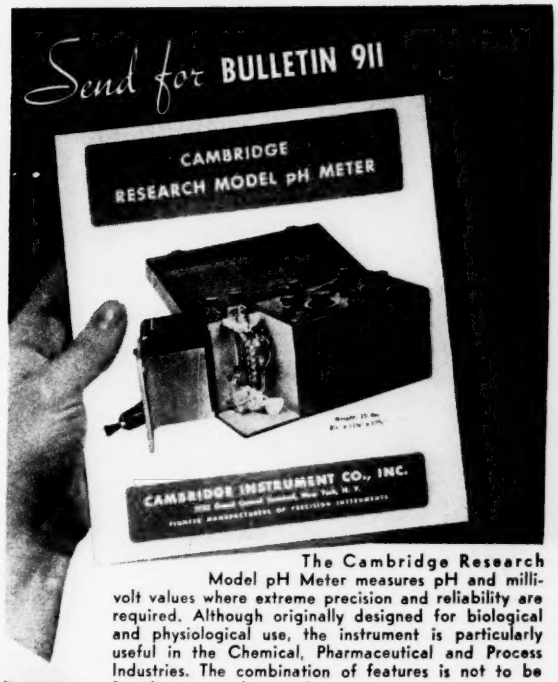
NEW! Hi-Volume AIR SAMPLER

- A basic instrument for AIR POLLUTION CONTROL. . . . originally designed by the N.Y. office of the A.E.C.
- Designed for indoor and outdoor sampling . . . Time tested . . . accurately samples particulate matter as small as 1/100th of a micron in diameter.
- "Inhales" an entire area . . . accomplishes in 10 minutes what previously units took over 36 hours to do.
- Hundreds being used by industry and government . . . for industrial hygiene depts., plant and insurance inspections, determining factory health hazards, atmospheric conditions, smoke abatement, smog, detecting radioactive material, etc.
- Portable . . . Plugs in any 110 volt outlet . . . Indispensable for unit or series sampling.

Write for NEW brochure, Bulletin 1-H4, on Air Samplers.

THE Staplex CO.
AIR SAMPLER DIVISION
784 Fifth Ave.
Brooklyn 32, N.Y.

For more information circle **190** on inquiry card.



The Cambridge Research Model pH Meter measures pH and millivolt values where extreme precision and reliability are required. Although originally designed for biological and physiological use, the instrument is particularly useful in the Chemical, Pharmaceutical and Process Industries. The combination of features is not to be found in any other similar instrument.

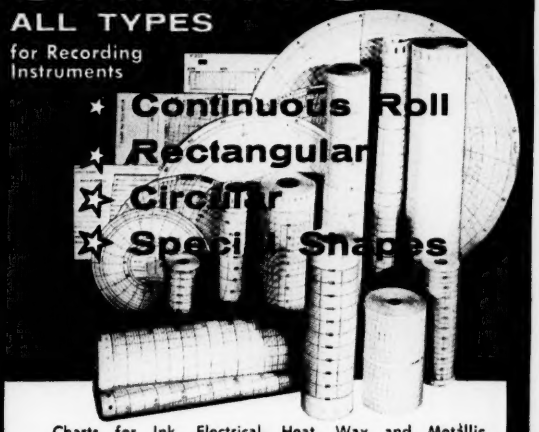
CAMBRIDGE INSTRUMENT CO., INC.
3554 Grand Central Terminal, New York 17, N. Y.

PIONEER MANUFACTURERS OF PRECISION INSTRUMENTS

For more information circle **191** on inquiry card.

GUBELMAN CHARTS

ALL TYPES
for Recording Instruments



Charts for Ink, Electrical, Heat, Wax and Metallic Stylus-Recording.

Special time numbering, perforations, and graphic design cycles available to meet unusual requirements.

All Charts are produced under automatically controlled atmospheric humidity conditions.

Our complete chart manufacturing facilities and wide experience have served and progressed with the instrument industry since 1908.

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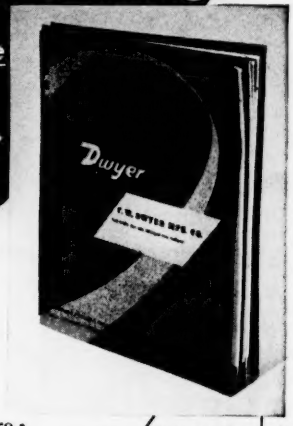
NEW 72-page GAGE and CONTROL Catalog

..tells where to use them..

..WHY and HOW!



Illustrates instruments and gages...*diagrams* their installation and on-the-job use... *charts* valuable performance data.

For the efficient measurement of combustion • draft • pressure • flow • vacuum • co_2 • smoke • velocity • static pressure • pressure differential • temperature • and others.

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P O BOX 373-S, MICHIGAN CITY, INDIANA

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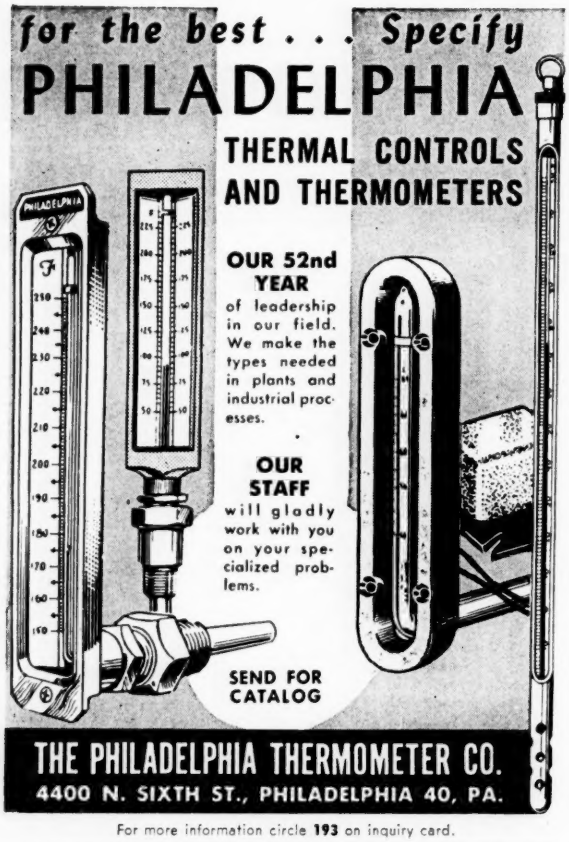
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PHILADELPHIA
THERMAL CONTROLS
AND THERMOMETERS
OUR 52nd YEAR
of leadership in our field. We make the types needed in plants and industrial processes.
OUR STAFF
will gladly work with you on your specialized problems.
SEND FOR CATALOG
THE PHILADELPHIA THERMOMETER CO.
4400 N. SIXTH ST., PHILADELPHIA 40, PA.

For more information circle **193** on inquiry card.

new plants and mergers

Robertshaw Fulton

ROBERTSHAW-FULTON CONTROLS CO. announces plans to construct its fifth research and development center. This $950,000 Eastern Research Center will be located at the Schuylkill Expressway, 14 miles from the center of Philadelphia.

THERMCO INSTRUMENT CORP. is the new name of THERMCO LABS with headquarters moved from Michigan City to La Porte, Ind.

VARIAN ASSOCIATES announces formation of a new Radiation Division.

BECKMAN INSTRUMENTS, Inc., upon advice of management consultants, has undergone major organizational changes by which a greater corporate control will result in closer coordination of its six domestic divisions namely: Scientific Instruments; Process Instruments; Berkeley; Helipot; Spinco; and Systems.

EPSCO, Inc. and **THE EDIN CO.** have merged. The latter will operate as a Division of Epsco.

TAURUS CORPORATION is the new name of *Metron Corporation,* Lambertville, N. J.

ARNOUX CORP. has opened an Eastern Regional Office in Great Neck, N. Y.

PACE
THERMOCOUPLE
REFERENCE
JUNCTION
NEW BRJ SERIES UTILIZES MAGNETIC AMPLIFIER CONTROL FOR EXTREME PRECISION —
1/5°F
STABILITY
• REFERENCE TEMPERATURES from 25° F above ambient to 250° F — *Special models for reference temperatures below ambient.*
• CHANNEL CAPACITY up to 48 channels in standard 110 volt rack or cabinet models.
• MULTI-WIRE junctions for thermocouple choice in each channel.
• THERMOCOUPLE TABLES for 150° F reference available. Write for your copy.
PACE engineering company
6914 Nick Avenue, North Hollywood, California • Phone POplar 5-0453

For more information circle **194** on inquiry card.

Some SANDSTEEL Pointers On Selecting SPRINGS
For Your Product
The two basic types of Sandsteel Springs are:
SPIRAL—For Ordinary Applications.
This is the common clock spring operated within a spring drum or anchored to a post so that it will function without support around its circumference. For starter, guard return springs, wind-up springs for toys or tension devices where constant torque is not critical.
SANDSTEEL CROSS-CURVED—For Super-Performance.
Subjected to our special cross-curving process. Curved across the width of the strip and wound against both its longitudinal spiral and its convex curvature.
This gives spring dual tension—providing dual power and a longer, more even energy release. Used where constant power is required through one or more revolutions. For timing instruments, carriage return springs, power springs for motion picture cameras, and other precision spring applications.
Write for free literature and case history files.
SANDVIK STEEL, INC.
SANDSTEEL SPRING DIVISION
Fair Lawn, New Jersey
Tel. SWarthmore 7-6200
In New York:—ALgonquin 5-2200

For more information circle **195** on inquiry card.

Switchcraft ▲

Librascope ►

SWITCHCRAFT, Inc. has moved into a new large plant recently completed on Chicago's Northwest side.

LIBRASCOPE's BURBANK DIV. has moved into a new 25,000-sq ft building in the same city.

SHALLCROSS MANUFACTURING CO. is moving to Selma, N. C., where a new 41,000-sq-ft plant is nearing completion.

SERVOMECHANISMS, INC. is moving (1) its Mechatrol Div. into a new 55,000-sq-ft building at Westbury,

L. I., (2) the Research Lab into a new expanded location at Santa Barbara Airport.

KEARFOTT's WESTERN DIV. in Van Nuys has been named the Microwave Div.

BAUSCH & LOMB announces that APPLIED RESEARCH LABS has become a wholly owned subsidiary through exchange of stock.

WEKSLER INSTRUMENTS CORP. is new name of Weksler Thermometer Corp. according to an announcement of Edward P. Dobrin, President of the corporation.

WALTHAM PRECISION INSTRUMENT Co. has acquired THERMAL DYNAMIC PRODUCTS, Inc. which will function as a division of Waltham.

The first book on this basic process subject:

CONTROL VALVES

by C. S. BEARD

Covers:	Basic Types
Valve Capacity and Cv	Sizing
Flow Characteristics	Positioners
Mechanical Features	Actuators

$2.00

ELECTRONIC CIRCUITRY

For Instruments and Equipment

(Second Edition)

by M. H. ARONSON

A complete home-study text and course, with 459 multiple-choice test items on basic electronic circuitry.

$2.00

INSTRUMENTS PUBLISHING CO.

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MARSH MAKES IT!

If it's a pressure gauge or dial thermometer, Marsh makes it . . . and makes it better. The types, ranges and case styles are endless. What is "special" to other instrument makers is often standard to Marsh. To know the scope of Marsh instruments—

Write for this fact-filled catalog

MARSH INSTRUMENT CO.,
Sales affiliate of Jas. P. Marsh Corporation,
Dept. 42, Skokie, Ill. *Export Dept.*, 3501 Howard St., Skokie, Ill.
Marsh Instrument & Valve Co. (Canada) Ltd., 8407 103rd St., Edmonton, Alta.

For more information circle **197** on inquiry card.

Special . . .

while they last . . .

THE AUTOMATIC FACTORY

by Stephen A. June, J. D. Bardis, L. H. Lurio, L. S. Polaner, O. Sagedahl, H. A. Sklenar and B. K. Yenken.

$1.50 Postpaid

Here is a fresh viewpoint on what tomorrow's "manless factories" CAN be—a book entirely free from the boresome generalities, platitudes, exaggerations and misconceptions that have been repeated by the majority of writers on this subject.

The viewpoint is fresh because the authors sought the TRUTH in the course of their project under General George F. Doriot at the Harvard School of Business Administration.

Here, then is THE book for all those who want FACTS rather than wild opinions.

88 pages, illustrated, 1955.

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GAUGES NOW COMPLETELY CATALOGED WITH ENGINEERING DATA

FOR PROCESS & POWER INSTRUMENTATION

IN PLANT & O.E.M.

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Ranges from 15 p.s.i., or 30" of vacuum, to 20,000 p.s.i.

Bourdon tubes of bronze, drawn or bored s/s, and other alloys

YOUR COPY SHOWING NEW GAUGES AND SPEC. DATA NOW AVAILABLE WRITE:

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For more information circle **199** on inquiry card.

See us at THE AUTOMATION SHOW!

GOW-MAC THERMAL CONDUCTIVITY GAS ANALYZERS

For gas mixing, process control and gas purity, including GAS BLENDERS and GAS MASTER PORTABLES.

Hot wire and thermistor type Gas Chromatography and "On Stream" T C Cells.

Hot wire filaments in matched pairs.

NEW POWER SUPPLIES! Two models especially for chromatography circuits—

a) High temperature helium and hydrogen operation of hot wire detectors.

b) Thermistor cell low current, high resistance operation.

5 MINUTE HOOK-UP

VISIT BOOTH 626, AUTOMATION SHOW!
N. Y. Coliseum, June 9th to 13th

ATTEND THE GOW-MAC CLINIC! Special lectures, demonstrations and discussion periods on thermal conductivity gas analysis. June 10th thru 12th.

GOW-MAC INSTRUMENT CO.
100 Kings Road • Madison, New Jersey

Gas Analysis by Thermal Conductivity Since 1935

For more information circle **200** on inquiry card.

people in the news

R. S. Doherty

M. M. Watkins

J. C. Koch

A. W. CASH VALVE MFG. CORP. announces election of *Raymond S. Doherty* as vice-president of the corporation.

CONOFLOW CORP. has a new president in the person of *M. Mark Watkins*, former executive vice-president. *R. B. Werey* retires as president, while *John C. Koch* has been appointed executive vice-president.

BROOKS ROTAMETER CO. has appointed *Richard P. Homiller* application engineer.

CANNON ELECTRIC has named *Robert Strich* Chief Engineer of its Los Angeles Division.

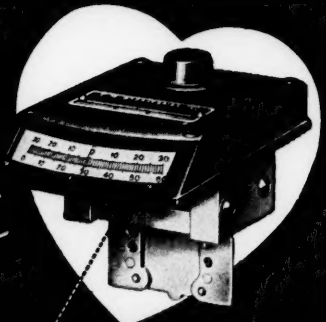
INTERNATIONAL RESISTANCE Co. announces appointment of *Edgar M. Corson, Jr.* as sales manager of the Computer Components Div.

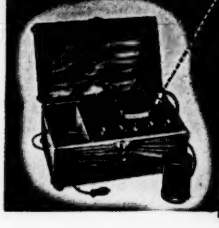
MANNING, MAXWELL & MOORE's Industrial Control Division announces appointment of *Edmund R. Lehman* as manager of application engineering.

Make a GM PORTABLE D'ARSONVAL

GALVANOMETER

the Heart of Your Instrument





FOR MEASURING LIGHT reflectance and color, the Photovolt Corporation of New York uses a Model 600 G-M Galvanometer for its popular Reflection Meter (left). Whatever your own particular instrument field, you can achieve this same self-contained portability, ruggedness and high sensitivity with G-M Galvanometers. Complete catalog on request.

GM LABORATORIES, INC.

4316 NORTH KNOX AVE., CHICAGO 41

For more information circle **201** on inquiry card.

L. C. Menkes

A. I. Thompson

A. C. Schilling

HAMMARLUND MFG. CO. has appointed *L. C. Menkes* sales manager of engineered products.

BARTON INSTRUMENT Corp. announces appointment of *A. I. Thompson*, formerly vice-president and sales manager, to vice-president in charge of sales.

TAGLIABUE MFG. CO. announces election of *Albert C. Schilling* as president of the company.

WESTON INSTRUMENTS announces appointment of *Erwin T. Higgons* as manager of the Milwaukee District Sales Office.

STATHAM INSTRUMENTS, Inc. has added nine application and sales engineers in a major expansion of its sales activities.

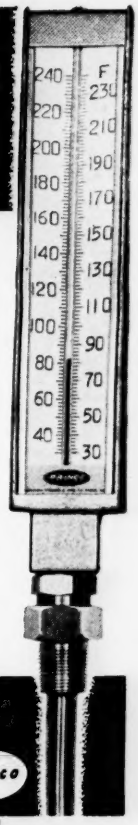
J. BISHOP & CO. Platinum Works has appointed *John J. Buckley* vice-president in charge of all company divisions in addition to his duties as general operations manager.

A. SCHRADER's SON Div. of Scovill Mfg. Co. announces appointment of *Phillip Hall* as manager of industrial sales.

MAGNETIC CONTROLS Co. has appointed *Glenn R. Stoltenberg* sales manager.

it's NEW! it's from PRINCO

THE NEW LOOK *in Industrial Thermometers*



PRINCO Industrial Thermometers, long known for their accuracy and rugged durability—are now wearing the most modern case on the market today. The familiar dependable PRINCO characteristics are still evident, for there has been no compromise with quality to bring you this new look.

These new PRINCO Industrial Thermometers feature:

- **Two Piece Individually Calibrated Scale with Tube Recessed Between Them to Prevent Parallax in Readings.**
- **Baked White Enamel Face with Sans-Serif Black Markings for Easy Reading.**
- **Cast Brass Case with Baked Hammertone Finish for Resistance to Industrial Vapors or Sea Atmosphere.**
- **Tapered Bulb Chamber and Tapered Inner Wall of Separable Well Assure Good Thermal Contact and Speed of Response.**
- **Easy Replacement of Glass.**

Available in many ranges within the broad limits of −120 F to +1200 F.

For complete information write for Bulletin F.

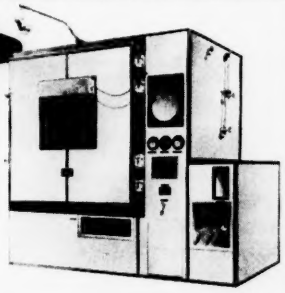
PRECISION THERMOMETER AND INSTRUMENT COMPANY

1434 BRANDYWINE STREET, PHILADELPHIA 30, PA. Rittenhouse 6-6671

PRINCO

For more information circle **203** on inquiry card.

DEVELCO



SALT SPRAY FOG TEST CHAMBER

To meet MIL-E-5272 and others.

TOP OPENING
FRONT OPENING
WALK-IN

Write for Bulletin SS-55

DEVELCO

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new literature

AUTOMATION

MAG-AMP CONTROLS. 2-page Bulletin F-8342-1 describes magnetic-amplifier positioning control.—Barber-Colman Co., 1300 Rock St., Rockford, Ill.

Circle **801** on inquiry card.

EDGE CONTROL. 8-page Bulletin 2-001, titled "Web Guide Simplified," describes air-jet detectors, hydraulic jet power, and other components for automatic control.—The North American Manufacturing Co., Hydraulic Controls Div., 4455 E. 71st St., Cleveland 5, Ohio.

Circle **802** on inquiry card.

SUPERVISOR'S EQUIPMENT. 20-page Bulletin GET-2738 gives description, operation and application of code-selector supervisory control equipment for master and remote stations, etc.—General Electric Co., Schenectady 5, N. Y.

Circle **803** on inquiry card.

MERCURY SWITCH CONTROLLERS. 60-page Catalog 858 describes numerous automatic control devices for pressure, temperature, liquid level, etc.; also relays and mercury switches. —The Mercoid Corp., 4201 Belmont Ave., Chicago 41, Ill.

Circle **804** on inquiry card.

ARMATURE WINDER. Catalog page pictures and describes Model 46-MCA High Speed Small Armature Winder with new self-resetting automatic counter.—Geo. Stevens Mfg. Co., Inc., Pulaski Rd. at Peterson, Chicago 30, Ill.

Circle **805** on inquiry card.

INDUSTRIAL INSTRUMENTS. 24-page Price List covers pressure, liquid level, and other controls, telemetering components, etc., includes dimensions, wiring diagrams for all controls, etc. —Automatic Control Co., 995 University Ave., Saint Paul 4, Minn.

Circle **806** on inquiry card.

MARKING. 8-page catalog describes 25 standard machines for marking components, parts, products, and packages of the electrical and electronic industries.—Markem Machine Co., Keene, N. H.

Circle **807** on inquiry card.

MOTORS

SMALL MOTORS. 2-page bulletin describes Type B unidirectional non-geared motors for fans, etc.—Barber-Colman Co., 1300 Rock St., Rockford, Ill.

Circle **808** on inquiry card.

MOTORS, POTS. 28-page Catalog BED-A90 describes "Micropots," "Microdials," and instrument motors; contains linearity definitions and other technical data.—Borg Equipment Div., The George W. Borg Corp., 120 S. Main St., Janesville, Wisc.

Circle **809** on inquiry card.

INTERMITTENT-DUTY MOTOR. 4-page bulletin describes new Type FSE-23 series-wound motor designed for intermittent-duty application such as adding machines, calculators, etc. Bodine Electric Co., 2254 W. Ohio St., Chicago 12, Ill.

Circle **810** on inquiry card.

VARIABLE-SPEED CONTROLS. Bulletin MRSB-101 describes MRS (Motor Rectifier Single) series which utilizes d-c motors operating from a-c power sources through variable-voltage autotransformers and silicon rectifiers.—Carpco Manufacturing, Inc., P. O. Box 3272, Jacksonville 6, Fla.

Circle **811** on inquiry card.

VALVES

FEED WATER REGULATOR. 4-page Brochure M85-1 describes thermo-hydraulic type regulator for small boilers.—Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio.

Circle **812** on inquiry card.

PACKLESS VALVES for high temperature applications. 4-page Engineering Bulletin 10-57 describes several valves for control of radioactive material which may be in the form of corrosive fused salts or liquid metals.—Hoke, Inc., 136 S. Dean St., Englewood, N. J.

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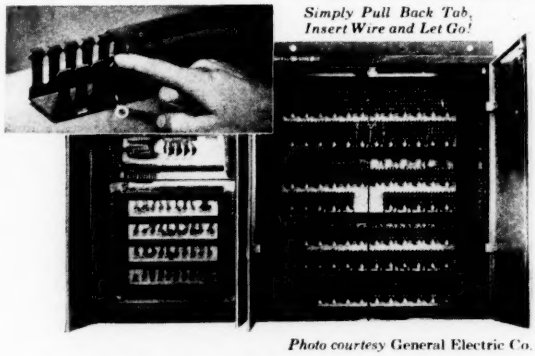

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SMALL VALVES. 12-page Catalog MV-957, titled 'Fluid Control Products," describes nine different valve series.—Hoke, Inc., 136 S. Dean St., Englewood, N. J.

Circle **814** on inquiry card.

PRESSURE REGULATORS. 20-page Cat. Sect. 2 describes 47 Oxweld industrial gas regulators and a new line of CO_2 regulators and regulator manifolds.—Linde Co., 30 East 42nd St., New York 17, N. Y.

Circle **815** on inquiry card.

PRESSURE REDUCING VALVE, Type DBI, direct-operated, is described in 2-page Bulletin-1051.—Copes-Vulcan Div., Blaw-Knox Co., 936 W. 36th St., Erie 4, Pa.

Circle **816** on inquiry card.

GATE VALVES. 8-page Bulletin F-24 describes new No. 76 3" aluminum gate valve with nylon discs said to be a major development in valve design.—Jordan Corporation, 6013 Wiehe Rd., Cincinnati 13, Ohio.

Circle **817** on inquiry card.

TEMPERATURE

PYROMETER. 6-page Bulletin 3885 describes Alnor Pyrotroller (R), and indicating-controlling pyrometer featuring reduction in both initial and maintenance costs.—Illinois Testing Labs., Inc., 420 N. LaSalle St., Chicago 10, Ill.

Circle **818** on inquiry card.

THERMOCOUPLE TABLES. 10-page spiral-bound booklet has two "front covers" and no 'back cover" (is turned over for changing from "mv to deg" to "deg to mv') and is indexed for further convenience.—Pace Engineering So., 6914 Beck Ave., North Hollywood, Calif.

Circle **819** on inquiry card.

THERMISTOR PROBES. 4-page Brochure EM-13 describes 9 specially-designed thermistor probe assemblies.—Fenwal Electronics, Inc., Mellen St., Framingham, Mass.

Circle **820** on inquiry card.

THERMISTORS AND VARISTORS. 12-page Technical Catalog V282 contains data and specs covering VECO stock items.—Victory Engineering Corp., P. O. Box 573, Union, N. J.

Circle **821** on inquiry card.

TEST FURNACES. 4-page brochure describes three high-temperature electric furnaces featuring 1F° uniformity and zone-by-zone heat adjustment; and matched control panels.—Marshall Products Co., 270 W. Lane Ave., Columbus 2, Ohio.

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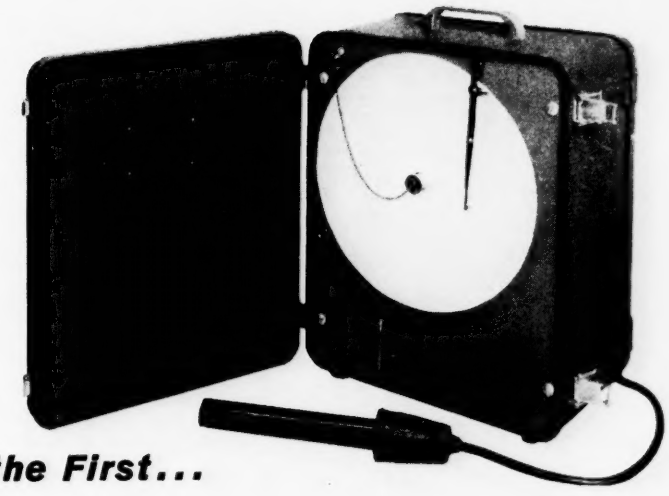

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NEW LITERATURE

ELECTRIC HEATING UNITS. heavy-duty type, are illustrated and specified in 4-page Bulletin 158.—Hevi-Duty Electric Co., P. O. Box 563, Milwaukee 1, Wis.

Circle **823** on inquiry card.

FLOW, LEVEL, PUMPS

FLOW-RATE TRANSMITTER. 4-page, Product Specification P22-4 describes application of Area Meter Pneumatic Transmitter to flow measurement, includes table of flow ranges and installation requirements.—Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio.

Circle **824** on inquiry card.

LIQUID LEVEL. 8-page Bulletin 13-22A describes new Type 13LA pneumatic liquid level transmitter utilizing differential pressure effect.—The Foxboro Co., Foxboro, Mass.

Circle **825** on inquiry card.

CORE ANALYSIS. Engineering Data Sheet E-57-3, "Maintaining Pressures in Core Analysis," covers application of Constametric miniPumps in core analysis.—Milton Roy Co., 1300 E. Mermaid Lane, Phila. 18, Pa.

Circle **826** on inquiry card.

RECYCLING GASES in Pilot Plants. Application Engineering Data Sheet E-57-2 describes the use of pulse generators to recirculate gases for reforming and hydrogenation processes in multiple-purpose pilot plants.—Milton Roy Co., 1300 E. Mermaid Lane, Phila. 18, Pa.

Circle **827** on inquiry card.

LIQUID METER. 6-page Bulletin 380-K4B describes Propeloflo velocity-type totalizing flowmeter for metering water and other liquids in waterworks and processing industries.—Builders-Providence, Div. of B-I-F Industries, Inc., Providence 1, R. I.

Circle **828** on inquiry card.

BALANCING FLOW DIFFUSERS. 12-page data book. Form 2071A, describes in detail how to test and balance air diffusers with an Alnor Velometer.—Illinois Testing Labs., Inc., 420 N. LaSalle St., Chicago 10, Ill.

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TURBINE FLOWMETER. 6-page Supplement 1 Catalog 10C1500 tells how a single basic calibration curve enables each F&P Turbine Flowmeter to be applied precisely, regardless of viscosity changes, to all flow measurement conditions.—Fischer & Porter Co., 602 Jacksonville Rd., Hatboro, Penna.

Circle **830** on inquiry card.

INDICATING FLOWMETERS. 4-page Bulletin V-100 describes movable-vane flowmeters and gives selection data for air, gas, and liquids.—Seico Instrument Div., Eclipse Fuel Engineering Co., 1100 Buchanan St., Rockford, Ill.

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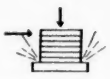

PRESSURE, WEIGHT

MANOMETERS. 4-page Publication No. TP-15-A-5 describes precision aneroid manometer, Type FA-129, a secondary calibrating standard for absolute pressure work.—Wallace & Tiernan Inc., 25 Main St., Belleville 9, N. J.

Circle **832** on inquiry card.

BELT (STREAM) WEIGHER. 2-page Bulletin 36-P1 describes Pneu-Weigh continuous weighing scale and available accessories.—Omega Machine Co., 345 Harris Ave., Providence 1, R. I.

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CONTINUOUS WEIGHING. 2-page Bulletin 36-P1 describes Pneu-Weigh continuous weighing scale and principal accessories.—Omega Machine Div., B-I-F Industries, Inc., 345 Harris Ave., Providence 1, R. I.

Circle **834** on inquiry card.

SINTER-PLANT CONTROL. 4-page Bulletin 100-P1 is a reprint of article by Zatkovich and Hamlett in Instruments and Automation which compares volumetric with gravimetric blending systems; also discusses premeability measurement of the sinter bed, mixing sequence and moisture control.—Builders-Providence, Inc., 345 Harris Ave., Providence 1, R. I.

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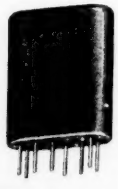

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TOTAL-PRESSURE PROBES. 4-page bulletin describes Kiel probes, said to be the most accurate available.—Airflo Instrument Co., 53 Addison Rd., Glastonbury, Conn.

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PRESSURE GAGES. 4-page Bulletin 100C describes new pressure gage case with three new safety features.—J. E. Lonergan Co., 2nd and Race Sts., Phila. 6, Pa.

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TIME

STOP WATCHES. 4-page Bulletin 345 describes Jaquet lab precision stop watches of hand, electric-contact and electromagnetic types.—Herman H. Sticht Co., Inc., 27 Park Place, New York 7, N. Y.

Circle **838** on inquiry card.

TIMERS. 2-page Form No. 162 describes 2500 Series spring-wound timer.—The Lux Clock Mfg. Co., Inc., 95 Johnson St., Waterbury 20, Conn.

Circle **839** on inquiry card.

DEW POINT, MOISTURE

MEASURING DEW POINT. 8-page Bulletin 2051 thoroughly describes unique Alnor Dewpointer (R) which uses principle of varying pressure, rather than temperature, in determining dew points of any gas sample.—Illinois Testing Labs., Inc., 420 N. LaSalle St., Chicago 10, Ill.

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AIR CONDITIONING. 8-page Bulletin 122, titled "Precise Control of Temperature and Moisture," describes uses of Type A conditioner.—Niagara Blower Co., 405 Lexington Ave., New York 17, N. Y.

Circle **841** on inquiry card.

FURNACE ATMOSPHERES. 2-page Bulletin DC-58 describes automatic control of dewpoint and/or carbon potential in endothermic type atmospheres by Dewtronik and Carbotronik instruments.—Ipsen Industries, Inc., 721 South Main St., Rockford, Ill.

Circle **842** on inquiry card.

VIBRATION

DISPLACEMENT PICKUPS. 4-page bulletin describes "Rectilinear Transducers."—Crescent Engineering & Research Co., 5440 N. Peck Rd., El Monte, Calif.

Circle **843** on inquiry card.

SIFTING MACHINES. 28-page booklet explains basic principles and describes various types of "NoVo-Screen" machines using sound vibrations, etc.—United Specialties Co., 9705 Cottage Grove Ave., Chicago 28, Ill.

Circle **844** on inquiry card.

VIBRATION MEASUREMENT. 8-page Vol. 4, No. 1 of Vibration Notebook features article "Eliminating Mechanical Failure" by Robert W. Stephens.—MB Mfg. Co., P. O. Box 1825, New Haven 8, Conn.

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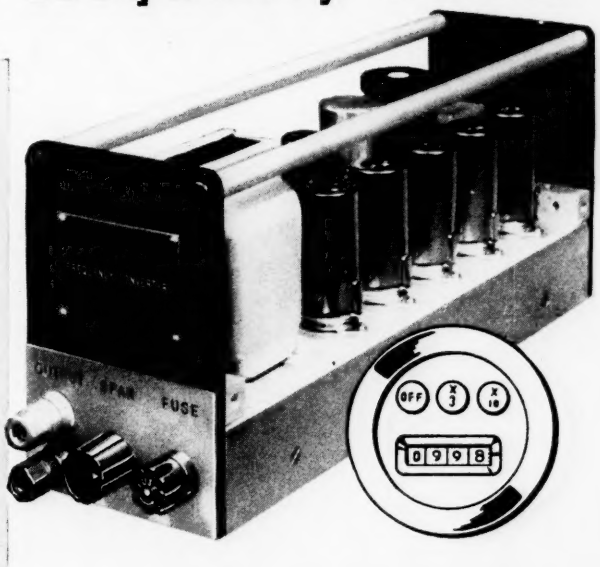
new cox frequency converter



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NEW LITERATURE

ANALYTICAL, LABORATORY

POLAROGRAPHY. 4-page Data Sheet E-94(3) describes Electro-Chemograph for polarographic analysis.—Leeds & Northrup Co., 4934 Stenton Ave., Phila. 44, Pa.

Circle **846** on inquiry card.

ELECTROLYTIC CONDUCTIVITY. 2-page Data Sheet ND47-95(1) describes Electromax Signalling Controller for use with electrolytic conductivity cells.—Leeds & Northrup Co., 4934 Stenton Ave., Phila. 44, Pa.

Circle **847** on inquiry card.

INFRARED INSTRUMENTS. 8-page Bulletin 724 describes Double-Beam IR-5 and Single-Beam IR-6 infrared spectrophotometers; lists complete line of liquid, gas, and solid sampling equipment.—Beckman/Scientific Instruments Div., Fullerton, Calif.

Circle **848** on inquiry card.

INFRARED ANALYSIS OF SULFUR DIOXIDE. 4-page Application Data Sheet IR-4201 gives detailed information on three important areas of SO_2 analysis.—Beckman/Process Instruments Div., 2500 Fullerton Rd., Fullerton, Calif.

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GAS ALARM. 2-page bulletin describes new small Explosilarm self-contained combustible gas alarm with tamperproof controls.—Mine Safety Appliances Co., 201 N. Braddock Ave., Pittsburgh 8, Pa.

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PHOTOFLUOROMETER. Bulletin B-245 describes Model 12C electronic photofluorometer for measurement of compounds measurable by fluorescence.—Coleman Instruments Co., 318 W. Madison St., Maywood, Ill.

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PHOTOMETER. 6-page Bulletin 2295 describes new Aminco Absolute Light-Scattering Photometer which measures turbidity, dissymmetry, depolarization and angular scattering.—American Instrument Co., Inc., 8030 Georgia Ave., Silver Spring, Md.

Circle **852** on inquiry card.

CHROMATOGRAPHY. 4-page brochure, and accompanying spec sheets, cover the Chroma-Matic 111, capable of analyzing six identical streams or six different streams.—Greenbrier Instruments Inc., Ronceverte, W. Va.

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CHROMATOGRAPHY. 2-page Bulletin describes Model A-125 Chromatocab, Formica-lined chromatography cabinet.—Research Specialties Co., 2005 Hopkins St., Berkeley 7, Calif.

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PETROLEUM COLOR. 8-page Bulletin FS-273 describes "Fisher ASTM Colorimeters," to determine color of petroleum products in terms of international chromaticity values.—Fisher Scientific Co., 360 Fisher Bldg., Pittsburgh 19, Pa.

Circle **855** on inquiry card.

VAPOR-PRESSURE APPARATUS. 4-page Bulletin FS-272 describes new speedy, high-accuracy technique of measuring vapor pressure from 1-cc samples.—Fisher Scientific Co., 360 Fisher Bldg., Pittsburgh 19, Pa.

Circle **856** on inquiry card.

LAB EQUIPMENT. 32-page 32nd edition of "What's New for the Laboratory" describes new balances, culture tubes, an electric furnace, new Corning items, two new machines for chromatographic and electrophoretic separations, a new centrifuge, and many other items.—Scientific Glass Apparatus Co., Inc., Bloomfield, N. J.

Circle **857** on inquiry card.

VACUUM AND GLASS WORKING. 4-page catalog describes diffusion pumps, blow torch, etc.—Research Vacuum Supply Co., 6712 N. Clark St., Chicago 26, Ill.

Circle **858** on inquiry card.

OVEN. 4-page Bulletin 2299 describes new Aminco Equa-Therm 17-cu-ft high-temperature high-performance oven.—American Instrument Co., Inc. 8030 Georgia Ave., Silver Spring, Md.

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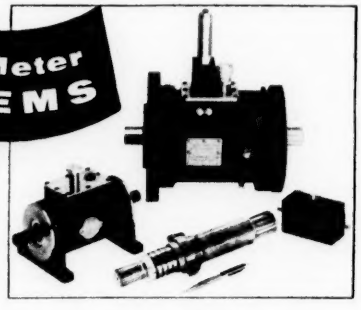

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TESTING, GAGING

RUNNING TORQUE TESTERS and Dynamometers. 8-page Bulletin 811 describes standard and special models for testing fhp motors.—John Chatillon & Sons, 85 Cliff St., New York 38, N. Y.

Circle **860** on inquiry card.

CORE TEST JIGS. 2-page Bulletin 57-E describes use of Models 4021 and 4022 Manual Core Test Jigs.—Rese Engineering, Inc., 731 Arch St., Phila. 6, Pa.

Circle **861** on inquiry card.

WAVEGUIDES. TESTERS. 48-page Catalog 58CB describes more than 300 different types of microwave waveguide components, test equipment and pressure windows.—Microwave Associates, Inc., Burlington, Mass.

Circle **862** on inquiry card.

CENTER FINDER. Two 4-page bulletins describe Schwieterman center finders for use in toolrooms and precision machining.—Precision Gage & Tool Co., 320 E. Third St., Dayton 2, Ohio.

Circle **863** on inquiry card.

ELECTRONIC TESTING EQUIPMENT. 32-page Catalog 58 covers several dozen different instruments and components.—Weinschel Engineering, Kensington, Md.

Circle **864** on inquiry card.

DATA HANDLING

DEGAUSSER. 2-page bulletin describes an automatic bulk tape degausser for safe, clean erasure of magnetic tapes.—Instrumentation Div., Ampex Corp., 934 Charter St., Redwood City, Calif.

Circle **865** on inquiry card.

TELEMETERED DATA PROCESSING. Five 2-page catalog bulletins describe MC series of monitor consoles designed to provide a visual display of PW telemetering signals in bargraph form on a scope screen.—Applied Science Corp. of Princeton, P. O. Box 44, Princeton, N. J.

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MAGNETIC TAPE. 16-panel accordion folder shows features of each popular "Scotch" brand magnetic tapes for audible range recording.—Minnesota Mining and Manufacturing Co., Dept. A8-89, St. Paul, Minn.

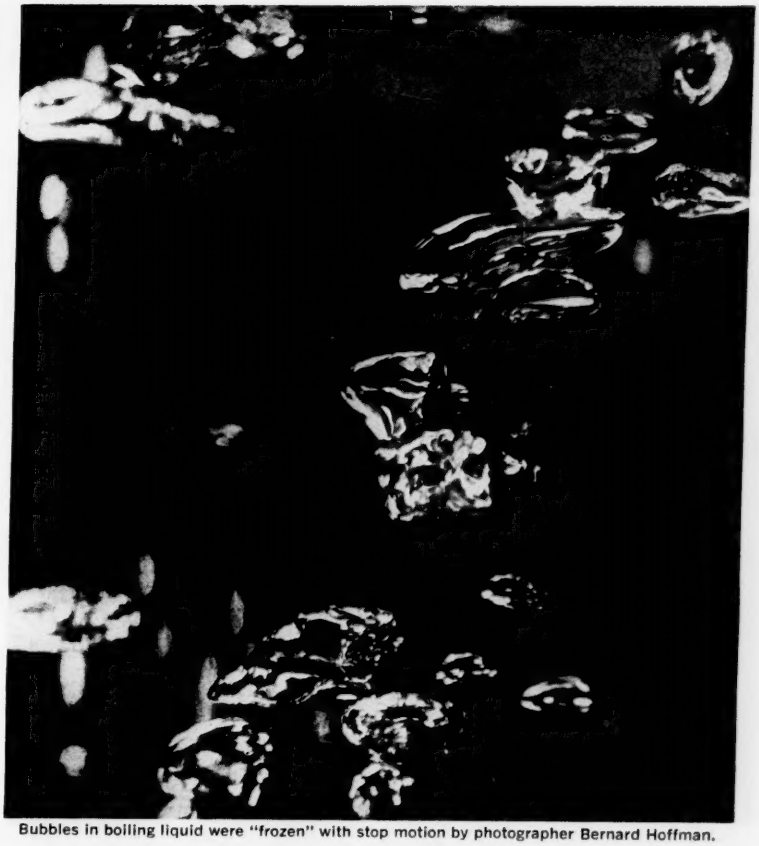
Circle **867** on inquiry card.

DATA PROCESSING. 6-page Bulletin 108a covers all-electronic automatic data systems.—The Kybernetes Corp., Div. of Self Winding Clock Co., Inc., 75 Varick St., New York 5, N. Y.

Circle **868** on inquiry card.

DATA PLOTTER. 8-page brochure gives condensed specs of Model 201 high-speed digital plotter which plots up to 20 symbols per second on 11" paper.—Tally Register Corp., 5300 Fourteenth St., N. W., Seattle, Wash.

Circle **869** on inquiry card.



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NEW LITERATURE

SHAFT-POSITION ENCODER. 2-page Catalog Sheet 32A100 describes new Model 32AA2 Digi-Coder the output of which can be fed into an electric typewriter, tape punch, computer, or printer.—Fischer & Porter, 542 Jacksonville Rd., Hatboro, Penna.
Circle **870** on inquiry card.

FUNCTION GENERATOR. 2-page bulletin describes Model 100 general purpose diode function generator for analog computers. Its output voltage is a programmed function of input voltage.—Electrol, Inc., 9000 W. Pico Blvd., Los Angeles 35, Calif.
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VOLTAGE-DIGITAL CONVERTER. 4-page brochure describes new fully-transistorized Voldicon featuring 2000 separate conversions per second and four types of outputs selectable by pulling slides.—Adage, Inc., 292 Main St., Cambridge 42, Mass.
Circle **872** on inquiry card.

DIGITAL SYSTEMS. 4-page brochure entitled "Digital Systems with Built-In rely/ance" explains maker's engineering philosophy and catalogues voltmeter, ratiometer, ohmmeter, control and printer units; a-c converters and master scanners.—Cubic Corp., 5575 Kearny Villa Rd., San Diego 11, Calif.
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ELECTRICAL, ELECTRONIC INSTRUMENTS

RECTILINEAR RECORDING MILLIAMMETERS. Single and dual "rectiriters" are described in Bulletins R 501 and R 502, 6 pages each.—Texas Instruments Inc., Industrial Instrumentation Div., Houston 6, Texas.
Circle **874** on inquiry card.

BAND-PASS FILTER. 10-page reprint of paper, "Active, Adjustable Audio Band-Pass Filter" by J. Ross Macdonald, reprinted from Journal of Acoustical Society of America.—Texas Instruments, 6000 Lemmon Ave., Dallas 9, Texas.
Circle **875** on inquiry card.

INDICATING INSTRUMENTS. 36-page Catalog 37 gives detailed descriptions of maker's more popular types available from stock.—The Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland 8, Ohio.
Circle **876** on inquiry card.

TACH AND V-O-M. 2-page bulletin describes Speedvolter tachometer and volt-ohmmeter for measuring speed as well as ac-dc volts and resistance.—Servo-Tek Products Co., 1086 Goffle Rd., Hawthorne, N. J.
Circle **877** on inquiry card.

VHF and UHF EQUIPMENT. 12-page Form 828C presents integrated line of instruments and accessories for signal and pulse generation, impedance measurement, detection, modulation, attenuation, and transmission through shielded coaxial lines.—General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.
Circle **878** on inquiry card.

AC VOLTAGE REGULATOR. 2-page technical data sheet describes tubeless universal Model APR1010 featuring unrivalled flexibility of operation: various sensing facilities allow it to regulate ac or dc loads at any voltage.—Sorensen & Co., Inc., Richards Ave., South Norwalk, Conn.
Circle **879** on inquiry card.

DIGITAL STRAIN GAGE Measurements. 4-page technical brochure "The Resistance Bridge Indicator and Its Applications" suggests many applications of this instrument.—Datran Electronics, 1836 Rosecrans Ave., Manhattan Beach, Calif.
Circle **880** on inquiry card.

BRIDGES. VHF admittance, universal, RF, component types; oscillators; meters for inductance, video noise level, etc; and waveform analyzers; are described in 4-page Catalog WK-01.—Wayne Kerr Labs., 2920 N. 4th St., Phila. 33, Pa.
Circle **881** on inquiry card.

TESTERS AND VOLTMETERS. 16-page catalog describes complete EICO line of electronic test instruments, voltmeters, etc. in both kit and wired form.—Electronic Instrument Co., Inc., 33-00 Northern Blvd., Long Island City 1, N. Y.
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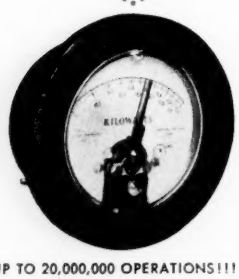

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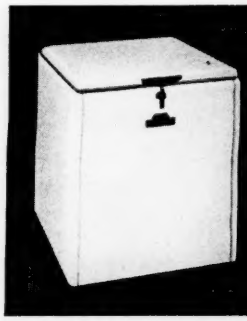

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BRIDGES. Three new catalog sheets 4 pages each: C-12 describes Model 260 Comparison Bridge; C-13 describes Model 290-R Universal Impedance Bridge; and C-15 describes Model 270 Capacitance Bridge.—Electro-Measurements, Inc., 7524 S.W. Macadam, Portland 1, Ore.

Circle **883** on inquiry card.

PULSE HEIGHT. 4-page bulletin describes new 50-channel Model PA-400 Multi-Channel Pulse Height Analyzer.—Eldorado Electronics, 2821 Tenth St., Berkeley, Calif.

Circle **884** on inquiry card.

SWEEPING OSCILLATORS. Noise Generators, Sound and Vibration Analysis Equipment and misc. instruments are described with full specifications in 56-page 1958/59 Catalog. Kay Electric Co., Maple Ave., Pine Brook, N. J.

Circle **885** on inquiry card.

GALVANOMETER. Leaflet announces a general-purpose galvanometer for recording and indicating applications.—Engineering Enterprises Inc., 1200 18th St., N. W. Washington 6, D. C.

Circle **886** on inquiry card.

AMPLIFIER. 2-page bulletin describes Series 101 high-temperature silicon transistor amplifier with unique circuitry.—Precision Inc., 730 Lyndale Ave. N., Minneapolis, Minn.

Circle **887** on inquiry card.

ROTARY PICKUP. Spec sheet describes new miniature inductive Type RT-22B Rotary Transducer.—Crescent Engineering and Research Co., 5440 N. Peck Rd., El Monte, Calif.

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H-F PULSE GENERATOR. 2-page Bulletin 57-C describes Model 1050 high-frequency (up to 500 kc) current pulse generator capable of high current outputs (up to 3 amp).—Rese Engineering, Inc., 731 Arch St., Phila. 6, Pa.

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P-R CONVERTERS. 6-page Preliminary Data Sheet gives many details on FR-300 Series transistor pulse rate converters.—Waugh Engineering Co., 7842 Burnet Ave., Van Nuys, Calif.

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PICKUPS AND CARRIER SYSTEMS. 6-page Short Form Catalog covers carrier systems and "Transducers."—Crescent Engineering & Research Co., 5440 N. Peck Rd., El Monte, Calif.

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PHASE ANGLE VOLTMETERS. 16-page Application Notes present technical information outlining specs and details on Models VM-202R, 202AR, and 202BR.—Instrumentation Div., North Atlantic Industries, Inc., 603 Main St., Westbury, N. Y.

Circle **892** on inquiry card.

ELECTROMETER-MEGOHMMETER. 4-page Bulletin No. 1 describes Type 8; includes complete technical specs and description of Type 9 resistance sample holder.—Walter N. Trump, 516 S. Vermont Ave., Columbus, Kansas.

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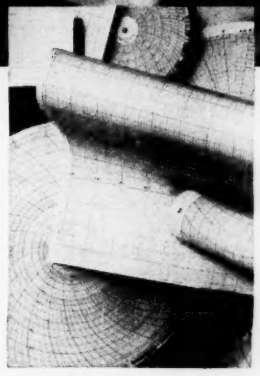

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NEW LITERATURE

COMMUNICATIONS. 2-page bulletin, titled "Custom-Engineering', affords a glimpse of facilities and products.—Rixon Electronics Inc., 2414 Reedie Dr., Silver Spring, Md.
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AMPLIFIERS. 6-page Bulletin 1-58-A describes a family of precision d-c instrumentation amplifiers with unique optional features.—Dynamics Instrumentation Co., 1118 Mission St., South Pasadena, Calif.
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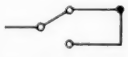

SWITCHES, RELAYS

SLIDE SWITCHES. 2-page Bulletin 366 includes new heavy-duty 3-amp switches with ratings and dimensional drawings.—Continental Carbon, Div. of Wirt Co., 5221 Greene St., Phila. 44, Pa.
Circle **896** on inquiry card.

MERCURY RELAYS. 2-page Form 2-58-5 describes four new types of mercury switches.—Hamlin Inc., 1316 Sherman Ave., Evanston, Ill.
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MERCURY RELAYS. 2-page Bulletin describes "RotoRelay," featuring mercury-to-mercury contact, smooth action, and efficient magnetic rotator.—Corona Engineering Service, 94-52 Corona Ave., Elmhurst 73, L. I., N. Y.
Circle **898** on inquiry card.

LIMIT SWITCHES. 4-page Data Sheet 138 describes complete line of small 2-circuit limit switches which handle loads usually assigned to much larger units.—Micro Switch, a Div. of Minneapolis-Honeywell Reg. Co., Freeport, Ill.
Circle **899** on inquiry card.

LATCH RELAYS. 4-page Bulletin 7305-PML describes new type "PML" latch relay which lines up with standard Type PM relays with no increase in height.—The Clark Controller Co., 1146 E. 152nd St., Cleveland 10, Ohio.
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SUB-MINIATURE RELAYS. hermetically sealed suited for airborne applications are specified and described in 6-page bulletin.—Phillips Control Corp., 59 W. Washington St., Joliet, Ill.
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MIRCO-MINIATURE RELAYS. hermetically sealed, are specified and described with dimensional drawings in 20-page bulletin.—Filtors, Inc., 30 Sagamore Hill Dr., Port Washington, L. I., N. Y.
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RESISTORS, POTENTIOMETERS

RESISTORS. 32-page Catalog 58 covers an outstanding selection of controls and resistors.—Clarostat Mfg. Co., Inc., Dover, N. H.
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POTENTIOMETERS. single and multi-turn precision types, are specified and described in 4-page bulletin, announcing immediate delivery from stock by distributors.—Spectrol Electronics Corp., 1704 South Del Mar Ave., San Gabriel, Calif.

Circle **904** on inquiry card.

POTENTIOMETER. 4-page brochure describes new model SP-1-10 four-speed "Accu-Rite" recording potentiometer featuring 2-second pen travel for full 10" scale.—Engineering Enterprises, Inc., 1200 Eighteenth St., N.W., Washington 6, D. C.

Circle **905** on inquiry card.

V-D RESISTORS. 12-page Catalog P 103, titled "Precision Potentiometers," describes precision units with 1 to 15 turns.—Analogue Controls, Inc., 39 Roselle St., Mineola, N. Y.

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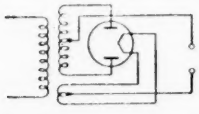

POWER SUPPLIES

POWER SUPPLY. 2-page technical data sheet describes new wide-range 100-va 45-200-cps Model FCR100 Frequency Changer featuring excellent regulation and waveform.—Sorensen & Co., Inc., Richards Ave., South Norwalk, Conn.

Circle **907** on inquiry card.

POWER PACKS. 8-page Bulletin 765 "A New Approach to Practical Control," discusses use of power supplies as basis for automation.—Electronic Measurements Co., Inc., Eatontown, N. J.

Circle **908** on inquiry card.

POWER SUPPLIES. 8-page March 1958 issue of Lambda Power Supplies Newsletter describes several new models and announces that first 5-year guarantee on power supplies has been made retroactive since 1953.—Lambda Electronics Corp., 1111 131 St., College Point 56, N. Y.

Circle **909** on inquiry card.

TRANSISTORIZED POWER SUPPLIES. 2-page Leaflet TPC-258 contains specifications and data on Series TPC-7 transistorized power supplies.—Southwestern Industrial Electronics Co., 2831 Post Oak Rd., Houston 19, Texas

Circle **910** on inquiry card.

POWER SUPPLIES. dc type; ac line regulators; and static inverters are illustrated and specified in 8-page Catalog E58.—Perkin Engineering Corp., 345 Kansas St., El Segundo, Calif.

Circle **911** on inquiry card.

POWER SUPPLIES. 4-page Bulletin 21 describe Regatron programmable power packs.—Electronic Measurements Co., Inc., Lewis St. and Maple Ave., Eatontown, N. J.

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TWO PHASE POWER SUPPLY. Spec. sheet describes PS2P-1, designed to speed development and testing of 400-cycle servo systems and motors for missiles and aircraft.—Pacific Technical Co., 2047 Sawtelle Blvd., Los Angeles 25, Calif.

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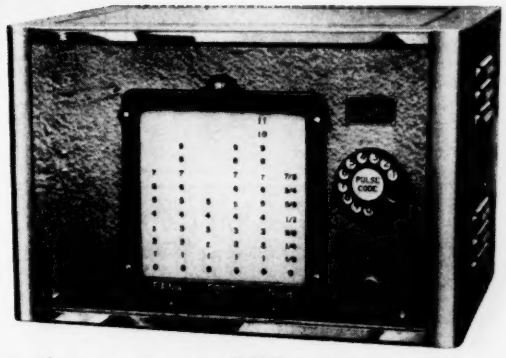

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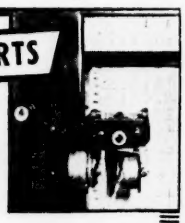

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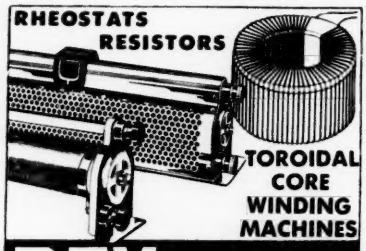

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NEW LITERATURE

MAGNETICS

PERMANENT MAGNETS. 12-page Manual No. 5 discusses the hysteresis loop and demagnetization curve; describes types of permanent magnet materials, temperature limitations, directional properties, incremental permeability, and hysteresis loss; ends with a glossary of magnetic terms.—The Indiana Steel Products Co., Valparaiso, Ind.

Circle **914** on inquiry card.

MAGNETIC CORE TEST JIGS. 2-page Bulletin 57-E describes use of Models 4021 and 4022 Manual Core Test Jigs.—Rese Engineering, Inc., 731 Arch St., Phila. 6, Pa.

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PERMANENT MAGNET DESIGN. 20-page Bulletin 158 covers p-m applications, properties, design, testing, stabilization and magnetization of finished magnets.—Thomas & Skinner, Inc., 1184 East 23rd St., Indianapolis 7, Ind.

Circle **916** on inquiry card.

ELECTRICAL, ELECTRONIC COMPONENTS

ELECTRICAL COMPONENTS. Binder contains ten 2-page and five 4-page bulletins on sensitive relays, small power dc motors, tachometer generators, choppers, etc.—Barber-Colman Co., Dept. W, 1872 Rock St., Rockford, Ill.

Circle **917** on inquiry card.

CAPACITORS. 2-page bulletin gives specs on Tan-O-Mite Series TF, foil-type tantalum capacitors.—Ohmite Mfg. Co., 3601 West Howard St., Skokie, Ill.

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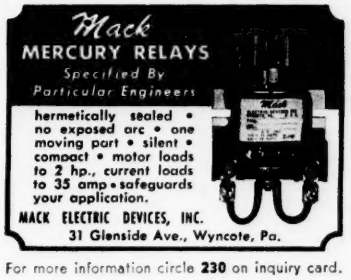
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CRYSTAL FILTERS. 4-page Bulletin XT-455 outlines stock and special miniaturized quartz crystal filters; includes technical data.—Burnell & Co., Inc., 10 Pelham Parkway, Pelham Manor, N. Y.

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TANTALUM CAPACITORS, seep and vibration-proof, Type TAK, in miniature sizes are rated with capacity-change curves, in 4-page engineering bulletin.—Pyramid Electric Co., 1445 Hudson Blvd., North Bergen, N. J.

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BOBBIN CORES. 8-page No. DN-100 of Dynacor Engineering Bulletin describes units for computer applications, wound with ultra-thin tape.—Dynacor Inc., 10431 Metropolitan Ave., Kensington, Md.

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SEALS, HOLDERS, etc. 16-page Catalog 657D describes complete line of end seals, crystal holders and mounts, and transistors and diode closures.—Hermetic Seal Corp., 29 S. 6th St., Newark 7, N. J.

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ROTARY SOLENOIDS. 2-page data sheet covers specs and operating data of new Motoroid type of rotary solenoid.—Leetronics Inc., 30 Main St., Brooklyn 1, N. Y.

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RF FILTERS. 4-page bulletin announces "a major breakthrough" in delivery time and unit costs of RF filters, some 90 basic filters with possibilities of some 20,000 combinations.—All-Tronics, Inc., Westbury, L. I., N. Y.

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WAVEGUIDE BENDS are illustrated with dimensional drawings in 12-page Catalog C-158.—Microwave Development Labs., Inc., Wellesley, Mass.

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MECHANICAL COMPONENTS

MECHANICAL COMPONENTS. 128-page Catalog #14 lists over 4,000 precision instrument components available from stock: gears, shafts, collars, differentials; many pages of technical data and specs.—PIC Design Corp., 477 Atlantic Ave., E. Rockaway, L. I., N. Y.

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ASSEMBLY COMPONENTS. Completely new 24-page supplement No. 15 lists over 500 newly designed packaged components.—PIC Design Corp., 477 Atlantic Ave., East Rockaway, L. I., N. Y.

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PRECISION SMALL PARTS. 16-page brochure describes many mechanical components classified in ten major groups such as clutches, m-p-film sprockets, etc.—LaVezzi Machine Works, 4635 West Lake St., Chicago 44, Ill.

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INSTRUMENT PENS. 4-page Bulletin 110-R1 describes new Never Dry sealed-capillary pens. Six sizes allow six-color recording with each record within ⅛" of time arc.—Arcco Instrument Co., Inc., 3113 East 11th St., Los Angeles 23, Calif.

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PRECISION GEARS, stocked in pitches from 48 to 120 with 14½° and 20° pressure angles, in miniature sizes, ⅛" face width, are listed and priced in 12-page Supplement 'A" to Catalog E-88.—Dynamic Gear Co., Inc., 20 Merrick Rd., Amityville, L.I., N. Y.

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SHOCK MOUNTING. 4-page Bulletin F1A describes engineered vibration and shock mounting systems for airborne electronic equipment and other applications.—Federal Shock Mount Corp., 1060 Washington Ave., New York 56, N. Y.

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TEFLON COMPONENTS. New standard sizes available in machined Teflon flexible couplings and expansion joints are described in Specifications SG-17 and SG-18.—Sentinel Glass Co., Hatboro, Penna.

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MATERIALS

ALUMINUM-IRON ALLOYS with high magnetic properties for laminations, cores, etc. in high-frequency applications are described with specifications in 4-page Technical Data Bulletin IND-18.—Metals & Controls Corp., General Plate Div., Attleboro, Mass.

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CRYSTALLINE CERAMIC. 8-page Progress Report No. 2 on Pyroceram materials covers Code 9606 and Code 9608 types, both available in commercial quantities.—Corning Glass Works, Corning, N. Y.

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PLASTICS FOR ELECTRONICS. 4-page short form catalog covers many various materials in company's lines of microwave absorbers, casting resins, plastic foams, plastic rods and sheets, reflectors and Luneberg lenses, etc.—Emerson & Cuming, Inc., 869 Washington St., Canton, Mass.

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REFRACTORIES. 4-page brochure describes properties and uses of stabilized Zirconia refractories which has a melting point in excess of 4200°F.—Saxonburg Ceramics, Saxonburg, Penna.

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FACILITIES

FACILITIES. 4-page brochure describes background of ten-year old company, its facilities, and many new statistics resulting from its ten years of operations.—Electronic Engineering Co. of Calif., 1601 E. Chestnut Ave., Santa Ana, Calif.

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COST-REDUCING STUDIES. Package of leaflets and folders includes the story on "How the Alden Work Simplification Lab Solves Cost Improvement Problems," description of Alden Mobile Fact Finder (direct reading in money) Lab, how Alden system equipment and lab relates itself to automation, etc.—Alden Systems Co., Alden Research Center, Westboro, Mass.

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NEW LITERATURE

PRECISION WIRE WINDINGS. 2-page bulletin describes service offered to electronic designers and manufacturers.—Brys Instrument Co., 7026 Sixth Ave., Brooklyn 9, N. Y.
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RUBBER COMPONENTS. 6-page Bulletin 715, titled "Customeering," outlines company's facilities and capabilities in manufacture of rubber and plastic components.—Ohio Rubber Co., Willoughby 1, Ohio
Circle **940** on inquiry card.

FACILITIES. 12-page brochure explains how company came to be and introduces personnel.—Greenbrier Instruments, Inc., Ronceverte, W. Va.
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HIGH-TEMPERATURE WIRES and cables, Teflon insulated, and their manufacturing facilities are subject of 4-page brochure.—American Super-Temperature Wires, Inc., Winooski, Vt.
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FABRICATION

BORING TOOLS. Spec sheet describes Adjustable Rough Boring Kit No. 1121, useful where a small tool inventory is desired and where storage space is a factor.—Madison Industries, Inc., Muskegon, Mich.
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ENCAPSULATION. 4-page Bulletin G6 entitled "How to Slush-Cast Molds for Epoxy Encapsulation" deals with Cerrotru low-temperature (218°F)-melting bismuth-tin alloy.—Alloy Sales Dept., Cerro de Pasco Sales Corp., 300 Park Ave., New York 22, N. Y.
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MISCELLANEOUS

PRESSURE TAPE. 2-page data sheet describes low-friction non-stick uses of "Temp-R-Tape" pressure-sensitive Teflon tape and thermal-curing pressure-sensitive Teflon-impregnated fibreglass tapes.—Connecticut Hard Rubber Co., 407 East St., New Haven 9, Conn.
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AIRCRAFT ENGINE RESEARCH. Six 2-page catalog inserts describe special instruments widely used for turbine development because they can measure temperature, pressure, flows, etc., at any desired point.—Airflo Instrument Co., 53 Addison Rd., Glastonbury, Conn.
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SAFETY ENCLOSURE. 6-page Technical Bulletin A-11 describes an all-purpose safety enclosure featuring modular construction.—S. Blickman, Inc., 8400 Gregory Ave., Weehawken, N. J.
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ENGINEERING MATERIALS and supplies are listed in new catalog; Part I, Field Equipment, has 26 pages, Part II, Drafting Supplies, has 50 pages.—Warren-Knight, 136 N. 12th St., Phila. 7, Pa.
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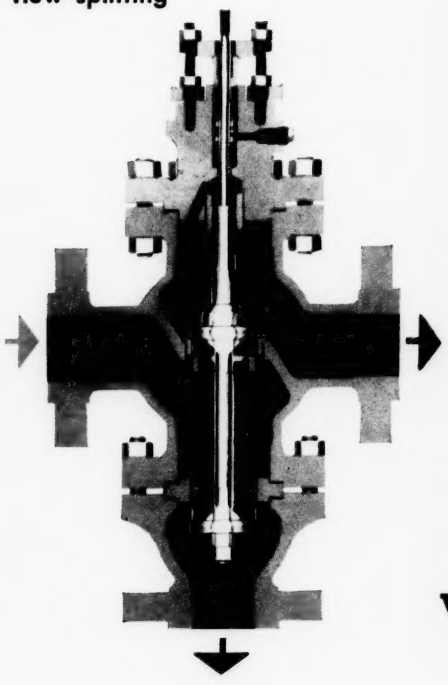

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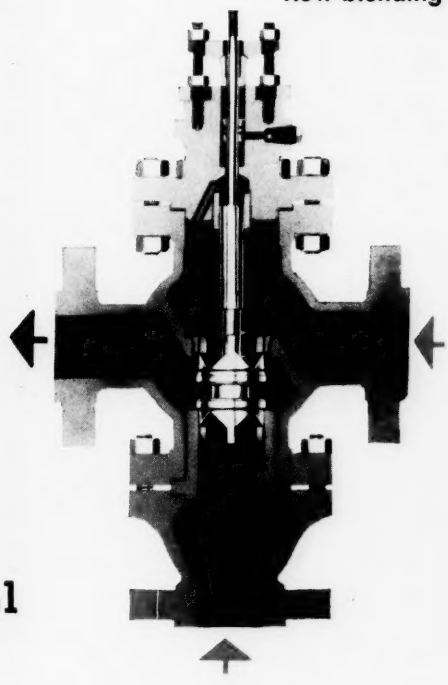
flow blending



SIMPLICITY . . . The one basic valve construction adapts to either flow blending or flow splitting control — through the feature of interchangeable plugs and lower seats (retained — no threads).

STABILITY . . . Direction of flow tends to unseat the plug heads — insuring stability over complete valve travel at maximum allowable pressure drop.

CAPACITY . . . Highest Cv of any Three-Way control valve. Both seats identical in area. Full flow capacity obtainable through either seat.

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